# **TECHNICAL MANUAL**

# DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

**FOR** 

TRUCK, FORKLIFT; 6, 000 LB.
VARIABLE REACH, ROUGH TERRAIN
NSN 3930-01-158-0849

This manual supersedes the Direct Support and General Support maintenance portion of TM 10-3930-660-24 dated 14 Oct 89.

Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY MARCH 1993



#### **CARBON MONOXIDE**

Carbon monoxide is colorless, odorless, DEADLY POISONOUS gas which, when breathed, deprives the body of oxygen and causes SUFFOCATION. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, apparent drowsiness, or coma. Permanent BRAIN DAMAGE or DEATH can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of fuel-burning heaters and internal-combustion engines and becomes DANGEROUSLY CONCENTRATED under conditions of INADEQUATE VENTILATION. The following precautions MUST be observed to insure the safety of personnel whenever the engine is operated for maintenance purposes.

- DO NOT operate the engine in an enclosed area unless it is ADEQUATELY VENTILATED.
- DO NOT operate the engine in an enclosed area such as a test cell without properly fitted and functioning exhaust ducts.
- BE ALERT at all times during engine operation for exhaust odors and exposure symptoms. If either are present, IMMEDIATELY VENTILATE the work area. If symptoms persist, remove affected personnel from the work area and treat as follows: expose to fresh air; keep warm; DO NOT PERMIT PHYSICAL EXERCISE; if necessary, administer artificial respiration as described in FM 21-11.



# HANDLING WEIGHTS

This manual considers short-term, non-repetitive lifts of equipment weighting up to 190 pounds to heights of about 3 feet. Under these conditions, this manual assigns one man for each 47-pound increment of weight up to a total of four men to accomplish the required lifts. If local conditions mandate higher lifts, repetitive lifts, or carries greater than 9 feet, refer to MIL-STD-1472 for a guideline on the number of personnel needed.



# **MECHANICAL HAZARDS**

Mechanical systems and components used on this equipment are energized, under pressure, or have sharp edges.

Use all precautions to de-energize a system, bleed pressure and to protect yourself from sharp edges when working on the equipment. Failure to do so may cause serious PERSONAL INJURY or DEATH.



# **HIGH NOISE DANGER**

Your hearing can be PERMANENTLY DAMAGED if you are exposed to constant high noise levels of 85 dB(A) or greater. Wear approved hearing protection devices when working in high noise level areas. Personnel exposed to high noise levels shall participate in a hearing conservation program in accordance with TB MED 501.



#### **USE OF COMPRESSED AIR TO DRY PARTS**

DO NOT exceed 15 psig nozzle pressure when drying parts with compressed air. DO NOT direct compressed air against human skin. Failure to do so may result in SERIOUS INJURY or DEATH.



Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.



#### FLAMMABLE LIQUIDS

Dry cleaning fluid, mineral spirits paint thinner, alcohol, acetone, methylethylketone and trichloroethylene are flammable solvents. Use these materials only in well-ventilated areas away from open flames and other heat sources that could cause ignition. The minimum safety measures described below must be observed in the handling and use of solvents:

- Fire extinguishers should be nearby when these materials are used.
- Cloths or rags saturated with cleaning solvents must be disposed of in accordance with authorized facilities procedures.
- The use of diesel fuel, oil, gasoline or benzine (benzol) is PROHIBITED for cleaning purposes.
- Fuel vapors can ignite and cause an explosion. Do not allow smoking or an open flame within 50 feet (16 meters).



#### PROPER MACHINE OPERATION

This equipment must be operated only by authorized personnel who have satisfactorily completed a program of training which must include familiarity with safe operating procedures, characteristics, and a knowledge of applicable codes, regulations, and facilities directives. Untrained personnel subject themselves and others to the possibility of DEATH or SERIOUS INJURY from the improper operation of this machine. Understand the equipment, its function, and the controls before operations are begun.



Hot oil or metal parts can cause severe burns. Wear insulated gloves, long sleeves, and eye protection when working with heated parts.



# HANDLING CLEANING AGENTS (SOLVENTS)

Toxic solvents are used in cleaning the equipment. Methyl-ethyl ketone TT-M-261 is a highly flammable solvent containing toxic characteristics that may irritate the skin and cause burns or internal disorders if fumes are repeatedly inhaled.

Trichloroethylene is a flammable solvent that has a chloroform odor. Inhaling concentrated fumes can cause unconsciousness. Inhaling fumes for a prolonged time can cause headache and drowsiness. Solvent absorbed by the skin can also result in internal disorders.

P-D-680 (Type II) is a flammable solvent that is potentially dangerous to personnel. Inhaling fumes for a prolonged time can cause headache and drowsiness. Solvent absorbed through the skin can also result in internal disorders.

The safety measures described below should be observed in the handling and use of solvents.

- Avoid prolonged or repeated breathing of vapors.
- Use only in a well-ventilated area.
- Keep away from heat, sparks, or open flames.
- Avoid contact with skin, eyes and clothing. The use of gloves is advised to prevent irritation or inflammation of the skin. If contact with the skin or eyes does occur, quickly wash the affected area with water for at least 15 minutes. For eyes, seek medical attention immediately after flushing eyes with water.

# **FIRST AID**

Refer to FM21-11 for applicable first aid information.

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# **SAFETY SUMMARY**

The following warnings and cautions appear in the text in the manual and are repeated here for emphasis.

# **WARNING**

Operation of a deadlined vehicle without preliminary inspection may cause further damage to a disabled component and possible injury to personnel. (page 2-2)

# WARNING

P-D-680 (Type II) is a flammable solvent that is potentially dangerous to personnel. Keep away from heat, sparks or open flame. Flash point of solvent is 1380F. Use only in a well ventilated area. Inhaling vapors over a long period of time can cause headache and drowsiness. Use gloves to prevent irritation or inflammation of the skin. Solvent absorbed through the skin can result in internal disorders. If contact occurs, wash the affected area with water for 15 minutes. For eyes, flush with water and then seek immediate medical attention. (page 2-18)

# **WARNING**

Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information. (page 2-18)

# **WARNING**

Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel. (page 2-18)

# WARNING

Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air. (page 2-18)

# WARNING

If the collet (11) is not correctly installed on the valve stem, it will unseat and be thrown with force when the spring compressor is released. The thrown collet could cause serious personal injury. (page 3-48)

# **WARNING**

Be sure engine is securely attached to engine stand. If engine falls from the stand, serious bodily injury could occur and the block and crankshaft could be damaged. (page 3-52)

# WARNING

Take necessary precautions to insure adequate personal safety while removing and installing the flywheel. The flywheel weighs more than 50 pounds. To avoid personal injury, use a suitable lifting device and hoist to remove the flywheel. (page 3-86)

# **WARNING**

Eye shields must be worn when removing the ring gear. Flying metal particles may cause injury to personnel. (page 3-87)

# **WARNING**

Wear insulated gloves and eye protection when installing the ring gear. Hot metal parts can cause severe burns.(page 3-87)

# **WARNING**

Keep clear of test spray from nozzle. Fluid at test pressures can penetrate skin, causing infection and possible death. (page 4-6)

# **WARNING**

To bleed fuel system, engine must be placed in a run condition. Because engine may start during bleeding procedure, all necessary safety precautions must be followed. See TM10-3939-660-10. (unit operation manual) (page 4-8)

#### WARNING

Do not exceed 30 psig nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury. (page 5-3)

# **WARNING**

Springs (61) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury. (page 7-15)

# **WARNING**

Ensure that retainer ring (60) is secure in groove before spring compressor tool is removed from retainer (59) to prevent spring (61) from flying out. Failure to follow this precaution could cause personal injury. (page 7-23)

# **WARNING**

The spring (10) is under compression. Use care when removing plug (8). (page 7-50)

# **WARNING**

Failure to use a retaining bolt or other means of restraint can cause injury when removing the no-spin differential (21). The no-spin differential (21) contains compression springs under pressure. (page 8-13)

# **WARNING**

Wear gloves and proper clothing while handling hot ring gear (22). Failure to follow this precaution could result in serious personal injury. (page 8-23)

# **WARNING**

Minor concentrations of acetic acid may be produced during application of silicone RTV-732 clear sealing compound. Adequate ventilation should be provided when silicone RTV is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor. (page 8-31)

# **WARNING**

Always use blocks, jackstands, or other rigid, stable supports when working beneath raised equipment. Ensure that hoists or jacks are in good condition. Never use frayed, twisted, or pinched cables. Never use bent or distorted hooks. Failure to follow this precaution could result in severe personal injury or machine damage. (page 10-3)

# **WARNING**

Do not put hands in front of the pistons. Failure to follow this precaution could result in severe personal injury. (page 10-4)

#### WARNING

DO NOT exceed 30 psig nozzle pressure when drying parts with compressed air. Always wear safety glasses. Do not direct compressed air against human skin. Failure to follow these instructions may result in SERIOUS INJURY or DEATH. (page 10-4)

# **WARNING**

Use only specified parts when assembling the disc brake. Do not mix parts from other disc brakes. If installing the wrong parts, the disc brake will not operate correctly and could result in severe personal injury and equipment damage. (page 10-6)

# WARNING

Plug (45) is under tension of spring (47). Use care when removing retaining ring to prevent personal injury.(page 10-10)

# **WARNING**

Hydraulic oil in the system can be under pressures over 1500 psi with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF and MLRS attachment on the ground, move all control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury. (page 14-4)

#### **WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (1) and allow pressure to escape before removing valve entirely. (page 16-41)

# **WARNING**

Before performing step 3a, make sure hoses (11) at front of boom assembly (8) are closed securely using metal plugs. Hydraulic oil under pressure can spray from hoses (11) causing bodily injury if hoses are not closed securely. (page 16-50)

# WARNING

Disconnect hoses (9) carefully during step lb. Hydraulic oil may be under pressure. (page 16-50)

# **WARNING**

Remove hose caps carefully prior to connecting hoses (9) in step 5b. Hydraulic oil may be under pressure. (page 16-55).

# **WARNING**

At operating temperatures, hydraulic oil is hot and under pressure. Hot oil can cause injuries. Allow hydraulic oil to cool before disconnecting any hydraulic lines. (page 16-58)

# **WARNING**

Spring (20) located in the cylinder block (17) is under high tension and can cause severe personal injury if retaining ring (21) is not removed correctly. (page 16-130)

# **WARNING**

Spring (20) can cause severe personal injury if retaining ring (21) is not properly installed. Use capscrew (A), flat washers (B), as required, and nut © to temporarily relieve pressure of spring (20) when installing retaining ring (21). (page 16-140)

#### **CAUTION**

Washing oil seals, electrical cables and flexible hoses with dry cleaning solvents or mineral spirits will cause serious damage or destroy the material. (page 2-19)

# **CAUTION**

Repaired items must be thoroughly cleaned to remove metal chips and abrasives to prevent them from entering working parts of the 6KVRRTFL. (page 2-22)

# **CAUTION**

When removing camshaft expansion plug (2) in step b, below, use care not to damage camshaft bore with drift. A damaged camshaft bore can lead to premature camshaft wear. (page 3-30)

# **CAUTION**

Do not clean cylinder in an acid bath unless camshaft bushing (1) has been removed. An acid bath can severely damage camshaft bushing. (page 3-31)

#### **CAUTION**

Do not lower cylinder head onto a flat surface as this could damage the valves. (page 3-37)

The bottom surface of the cylinder head and top of cylinder block must be clean of all residue and dry. Dirty surfaces could cause leaks or incorrect seat between the cylinder head and block. (page 3-49)

#### **CAUTION**

Be careful not to scratch or damage crankshaft when removing connecting rod caps and upper half of bearings. Any damage to the crankshaft could result in premature engine failure. (page 3-52)

# **CAUTION**

Use only nylon straps, or equivalent, to remove crankshaft from cylinder block. Be sure that nothing contacts the machined surfaces of the crankshaft. A scratched or damaged crankshaft could cause premature engine failure. (page 3-54)

# **CAUTION**

Be careful not to damage or scratch the crankshaft (14) (page 3-54).

# **CAUTION**

If crankshaft is not to be reinstalled within one hour after it is cleaned, apply lubricating oil on the bearing journals. Failure to comply with this recommendation will result in bearing journal corrosion. (page 3-55)

# **CAUTION**

Do not heat crankshaft gear (21) longer than 45 minutes. The gear will become permanently distorted if it is heated for longer than 45 minutes. (page 3-57)

# **CAUTION**

Be sure cylinder block bearing bores, backside of bearings and inner surface of bearing caps are clean and dry. Oil on these areas could cause less heat transfer between the bearings and the block which, in turn, could cause overheated bearings. (page 3-61)

# **CAUTION**

The four digit number stamped on the connecting rod and the rod cap must match and be facing the oil cooler side of the engine. Connecting rod and cap are machined as a set and must be kept that way. Failure to install matched sets could result in premature engine damage. (page 3-64)

# **CAUTION**

If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft. (page 3-68)

# **CAUTION**

Never use any type of rough material or tools such as sandpaper, emery or crocus cloth, files, or glassbead cleaning equipment to clean bearings. (page 3-69)

#### **CAUTION**

To help prevent damage to the cylinder block during main bearing bore cleaning, compressed air shall not exceed 15 psig. Use compressed air only with effective chip guarding and personal protective equipment. (page 3-69)

# **CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the removal of the upper bearing halves. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure. (page 3-77)

The seal lip and sealing surface on crankshaft must be clean to help prevent an oil leak around the seal. (page 3-81)

# **CAUTION**

The seal and seal pilot used in STEP 2 are packaged as a single item. Do not separate these two components before seal installation. Failure to use the pilot could result in a damaged seal. (page 3-81)

# **CAUTION**

Drive the alignment/installation tool at the 12, 3, 6, and 9 o'clock positions only. Driving the tool at other positions could damage the seal carrier. (page 3-81)

#### **CAUTION**

Always use the seal pilot (2) to install rear oil seal (1). Failure to do so could result in a damaged oil seal (1). (page 3-83)

# **CAUTION**

Do not use the timing pin to lock the engine. Use a barring tool to hold the engine crankshaft during flywheel installation. Using the timing pin as a locking device while tightening the flywheel mounting hardware could damage the pin. (page 3-86)

# **CAUTION**

Install new capscrews each time flywheel is removed to help prevent possible engine failure. (page 3-88)

# **CAUTION**

The rear oil seal must be clean to help prevent seal leaks. (page 3-92)

# **CAUTION**

Do not use bead blast to clean pistons. Bead blasting may damage piston. (page 3-95)

#### **CAUTION**

Maximum allowable bore diameter is 4.0203 inches. Make sure that ridge reamer does not gouge into cylinder bore or removes more metal than necessary. (page 3-99)

# **CAUTION**

If a strap-type ring compressor is used in STEP b, take care not to hook strap on a ring gap, as doing so could cause ring to break. (page 3-102)

# **CAUTION**

Do not remove shaft from support (12). The support and shaft must be replaced as an assembly. (page 3-106)

# **CAUTION**

Be careful not to drop the tappets (2) into the bottom of the pistons during tappet installation as this could damage the pistons. (page 3-109)

# **CAUTION**

If a new bearing is installed, the timing pin assembly must be accurately located. Failure to do so could result in improper timing adjustment. (page 3-119)

# **CAUTION**

When installing pump, be sure idler gear pin is installed in the locating bore in the cylinder block. Failure to properly locate oil pump can result in damage to pump and to cylinder block bore. (page 3-127)

Area around turbocharger supply line (6) should be cleaned thoroughly before removal of line (6). Failure to do so could result in contamination of turbocharger lubricant and premature turbocharger failure. (page 3-130)

#### **CAUTION**

If rust has formed on injector hold-down nut, injector can turn in its bore as hold-down nut is loosened. Dissolve and loosen rust as instructed in STEP 6. Failure to follow instructions in STEP 6 can result in severe damage to cylinder head. (page 4-6)

#### **CAUTION**

Do not use a wire brush on the compressor wheel. Use of a wire brush on compressor wheel may cause premature component failure. (page 4-18)

# **CAUTION**

When installing thrust collar (20), be sure balance mark on collar (20) is aligned with shaft (24) balance mark. Mark top surface of thrust collar (20) so alignment can be verified after installing thrust bearing (19). Failure to align balance marks could cause premature component failure. (page 4-19)

# **CAUTION**

When installing impeller (10), be sure to align balance marks on shaft (24) and impeller (10). Failure to do so could cause premature component failure. (page 4-20)

# **CAUTION**

Do not move bearing housing (2) when installing impeller (10). Moving bearing housing (2) during impeller (10) installation will cause improper balance and premature component failure. (page 4-20)

# **CAUTION**

Do not allow impeller (10) to turn when installing locknut (9). Failure to prevent impeller from turning will result in improper balance and premature component failure. (page 4-21)

# **CAUTION**

Be sure scribe marks on diffuser (13) bearing housing (2) and turbine housing (3) are properly aligned during assembly. Failure to properly align components could result in premature component failure. (page 4-22)

#### **CAUTION**

Do not attempt to clean radiator core fins with any sharp instrument. A sharp instrument may damage core, leading to leakage from core. (page 5-3)

# **CAUTION**

Be careful as rotor (7) is placed in slip ring end frame (5), not to damage brushes or rear seal (33). (page 6-9)

#### **CAUTION**

Do not clean starter parts in dry cleaning solvent. Dry cleaning solvent may damage certain electrical parts. (page 6-13)

# **CAUTION**

Do not turn down commutator nor undercut insulation between commutator bars. Replace armature if commutator cannot be restored satisfactorily in STEP 2, below. (page 6-14)

# **CAUTION**

Use care when removing seal rings (49) to prevent clutch shaft damage. (page 7-14)

Carefully handle clutch plates (57) so graphite doesn't flake off. Failure to follow this pre could cause equipment damage. (page 7-14)

#### **CAUTION**

Use care when installing assembled piston (63) to prevent damage to O-ring (64) and outer piston seal (65). (page 7-22)

# **CAUTION**

Do not start engine until both piston and tandem gear pumps are primed. Failure to follow this instruction may result in damage to pumps. (page 7-36)

# **CAUTION**

Use care when removing cover assembly (1). Clutch packs must remain in housing or clutch packs could be damaged during removal. (page 7-37)

# **CAUTION**

Use care when removing baffle pan (14). Failure to follow this pre will damage machine parts. (page 7-45)

# **CAUTION**

Do not overtighten vise jaws. Failure to follow this pre will cause part damage. (page 7-50)

# **CAUTION**

Use care when installing transmission control valve (3) so as to not lose balls (4) and spring (5). (page 7-53)

# **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure. (page 8-4)

# **CAUTION**

Do not heat rivets (27) before installation. Hot rivets (27) could damage ring gear (22) and flange case half (26). (page 8-23).

# **CAUTION**

Pressure on rivets (27) must be held for approximately one minute so that rivet body will completely fill hole. Failure to do so could cause rivet failure. (page 8-23)

#### **CAUTION**

Spacing between four initially installed capscrews (23) must be even to prevent uneven pressure on case halves when torqueing. Failure to do so could cause component failure. (page 8-25)

# **CAUTION**

When turning bearing adjusting rings (15), always use a tool that engages two or more opposite notches in the ring. A large screwdriver can be used for this purpose. Failure to do so could cause damage to adjusting ring lugs. (page 8-27)

# **CAUTION**

Inner oil seal (25) and bushing (24) in bore of spindle can be damaged when sliding spindle past axle splines. Remove spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure. (page 8-35)

#### **CAUTION**

Ring gear (18) must be heated before installation. Failure to heat ring gear (18) before installation could cause damage to differential case half (22) because of a tight fit. (page 9-20)

Do not heat rivets (28) before installation. Use only cold rivets for proper fastening. (page 9-21)

#### **CAUTION**

Install bearing caps (10) in correct location to avoid thread damage by cross threading or mismatch. (page 9-25)

# **CAUTION**

Install adjusting rings (12), using care not to cross-thread the rings or the caps. A plastic or leather mallet can be used to align the rings and caps during installation. DO NOT force adjusting rings; damage to threads may result. (page 9-25)

# **CAUTION**

Be sure bearing caps of differential fit inside lugs inside of axle housing. Do not force differential into housing or damage will occur to housing and differential. (page 9-30)

#### **CAUTION**

Use extreme care when removing and installing spool (53). Do not force spool (53) at any time during removal. Failure to follow this pre will result in part damage. (page 10-11)

# **CAUTION**

Ensure that ball is on seat (25) before proceeding. Failure to do so could cause part damage. (page 10-14)

# **CAUTION**

Care should be taken not to contaminate emergency steering pump during disassembly. Dirt and other foreign substances should be removed from surrounding area and pump before disassembling. Failure to follow this pre will cause part damage. (page 12-8)

# **CAUTION**

Do not bind spool (19) and sleeve (20) in valve housing (11). Failure to follow this pre will cause part damage. (page 12-9)

# **CAUTION**

Use care when installing spool (19) and sleeve (20) assembly to prevent shifting of parts. Failure to follow this pre will cause part damage. (page 12-11)

# **CAUTION**

Do not weld door side of hinge (7) to frame (4). Welding incorrect half of hinge (7) to frame (4) will result in damage to frame (4) and hinge (7). (page 13-4)

# **CAUTION**

When placing cab on stands, be sure no hoses or wires are between cab and stands. Failure to follow this procedure may result in damage to hoses or wiring. (page 14-6)

#### **CAUTION**

Prying notches are provided between the pump sections. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and damaged parts. (page 16-10)

# **CAUTION**

Gears are closely machined, therefore they must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals. (page 16-11)

Do not grip on or near any machined surfaces during disassembly or assembly. Failure to follow this pre will cause part damage. (page 16-13)

#### **CAUTION**

If parts are difficult to fit during assembly, tap gently with a soft hammer. Use care to prevent part damage. (page 16-16)

#### **CAUTION**

Do not scratch or damage the wear surface of rod (8), piston (15) or gland (9). Follow this pre to prevent failure of the cylinder. (page 16-42)

#### **CAUTION**

Use care when removing and installing rod (8) and piston assembly to prevent wear ring (12) damage. Keep rod (8) in line with cylinder tube to prevent binding. (page 16-42)

#### **CAUTION**

Do not nick or scratch seal groove during removal of seal (13) and rod wiper (19). Failure to follow this pre will cause part damage. (page 16-43)

# **CAUTION**

To prevent damage to lines (10) and electrical cable (1) during step 5a, place wood boards between underside of outer boom section and slings. (page 16-52)

# **CAUTION**

Be careful that lines (10) and electrical cable (1) on underside of outer boom section are not damaged when boom assembly (8) is lowered onto supports. (page 16-53)

# **CAUTION**

Use hoist and sling to make final alignment with cylinder rod eye and pivot pin hole. Do not use the joystick to make final alignment; damage to rod eye bushing could result. (page 16-54).

# **CAUTION**

To prevent damage to hoses (13, 14, and 15), and boom electrical cable (25), have an assistant guide hoses (13, 14, and 15) out rear of outer boom (2) during step 12g. (page 16-61)

#### **CAUTION**

Have an assistant guide hoses (13, 14, and 15) through hole near tensioner (20) while installing booms. (page 16-70)

#### **CAUTION**

Retract cylinder before removal. Failure to follow this pre will cause part damage. (page 16-99)

# **CAUTION**

Remove cylinder from sling with care to prevent part damage.(page 16-100)

# **CAUTION**

Be careful not to scratch the face of the valve block during bearing race (48) removal. (page 16-132)

#### **CAUTION**

Wafer plate (11) must be flat against valve block face. Check to make sure it does not rock back and forth. If rocking motion occurs, make sure locating pin (12) is bottomed out in the valve block (3). Wafer plate rocking will induce high stress conditions and cause fractures in the wafer plate. (page 16-142)

#### **CAUTION**

Be careful not to allow the piston to drop from piston rod as this could damage the piston. (page 16-142)

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# DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR TRUCK, FORKLIFT; 6,000 LB.

# TRUCK, FORKLIFT; 6,000 LB. VARIABLE REACH, ROUGH TERRAIN NSN 3930-01-158-0849

# REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2020-2 located in back of this manual direct to: Commander, US Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

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Approved for public release; distribution is unlimited.

<sup>\*</sup>This manual supersedes the Direct Support and General Support maintenance portion of TM10-3930-660-24 dated 14 Oct 89.

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# **HOW TO USE THIS MANUAL**

# 1. ABOUT YOUR MANUAL

Spend some time looking through this manual. You'll find that it has a new look, different than most of the TMs you've been using.

New features added to make this manual easier for you to use are:

- a. Finding Information These include entry features such as the thumb indexing indicators on the cover and edge of the manual. Extensive troubleshooting guides for specific systems lead directly to step-by-step directions for problem solving and maintenance tasks.
- b. **Illustrations** Many methods are used to make finding and fixing parts much easier. Locator illustrations with keyed text, exploded views, and cutaway diagrams make the information in this manual easier to understand and follow.
- c. **Keying Text With Illustrations** Instructions/text are located together with figures that illustrate the specific task you are working on. In most cases, the task steps and figures are located side by side.

This TM is organized so that the information and procedures, needed to perform maintenance tasks, is easily located. Take a few minutes to read through this How To Use part of the manual to learn how it is put together and how to find the information you need.

# 2. BEFORE YOU START

- a. Read and understand all and first aid data in the front of this manual. This data contains general shop safety practices not included in maintenance tasks.
- b. Read Chapter 1 to learn more about the 6KVRRTFL purpose, capabilities and features.

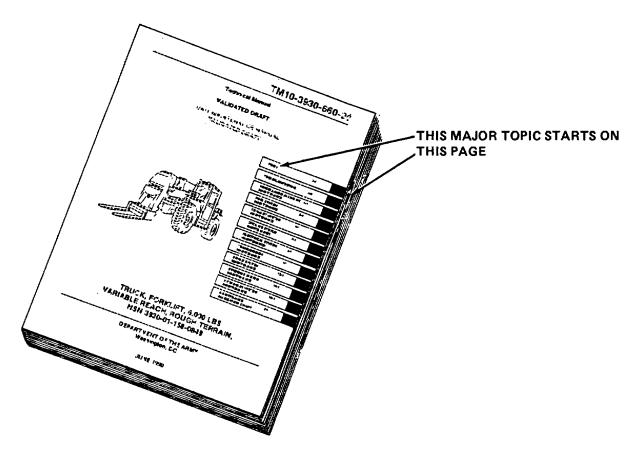
#### 3. CONTENTS OF MANUAL

- a. This TM contains direct support and general support maintenance instructions at the intermediate level for the 6KVRRTFL. Included are principles of operation, fault isolation troubleshooting, and corrective maintenance tasks as authorized by the Maintenance Allocation Chart (MAC).
- b. This TM is made up of:
  - (1) Chapters. There are 16 chapters.
    - (a) Chapter 1, Introduction. This chapter contains general 6KVRRTFL information of interest to intermediate level maintenance technicians.

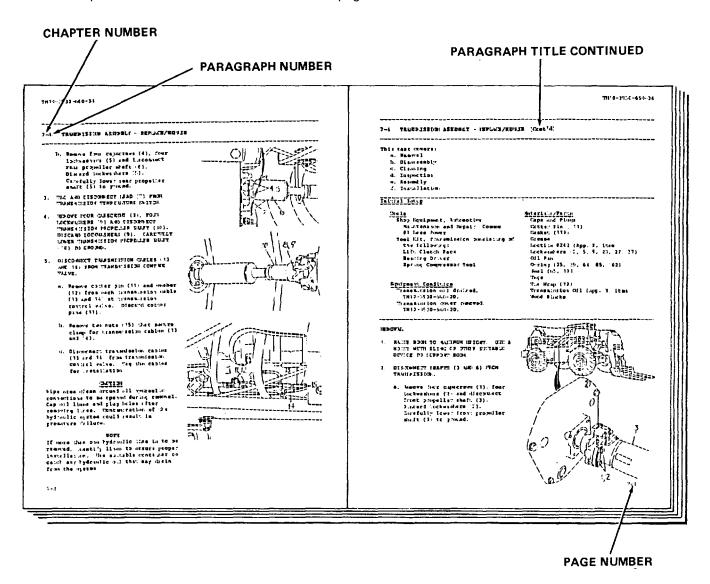
- (b) Chapter 2, Maintenance Instructions. This chapter contains instructions of interest to intermediate level maintenance technicians on tools, equipment, preventive maintenance and troubleshooting.
- (c) Chapter 3, Engine System Maintenance. This chapter contains engine maintenance divided by major systems.
- (d) Chapter 4, Fuel System Maintenance. This chapter contains maintenance of fuel system components.
- (e) Chapter 5, Cooling System Maintenance. This chapter contains maintenance of cooling system components.
- (f) Chapter 6, Electrical Systems Maintenance. This chapter contains electrical maintenance divided by major systems.
- (g) Chapter 7, Transmission Maintenance. This chapter contains maintenance of transmission components.
- (h) Chapter 8, Front Axle Maintenance. This chapter contains maintenance of front axle components.
- (i) Chapter 9, Rear Axle Maintenance. This chapter contains maintenance of rear axle components.
- (j) Chapter 10, Brake Maintenance. This chapter contains maintenance of brake components.
- (k) Chapter 11, Wheel and Tire Maintenance. This chapter contains maintenance of wheels and tires.
- (1) Chapter 12, Steering System Maintenance. This chapter contains maintenance of steering components.
- (m) Chapter 13, Frame and Towing Attachment Maintenance. This chapter contains maintenance of frame and towing attachment components.
- (n) Chapter 14, Body, Cab, and Hood Maintenance. This chapter contains maintenance of body, cab, and hood components.
- (o) Chapter 15, Body and Chassis Accessory Items Maintenance. This chapter contains maintenance of accessory components.
- (p) Chapter 16, Hydraulic System Maintenance. This chapter contains maintenance of hydraulic components.
- (2) <u>Sections</u>. All chapters are further subdivided into sections. Sections allow for easier break-up of material. They are:
  - (a) Chapter 1 has two sections: General Information and Equipment Description.

- (b) Chapter 2 has three sections: Repair Parts, Special Tools, TMDE and Support Equipment; General Maintenance, and Troubleshooting.
- (3) <u>Paragraphs</u>. Paragraphs make up sections. The paragraphs have the information needed to do the job properly. Each paragraph is the start of a major topic within the chapter.
- (4) <u>Pages</u>. Pages are numbered consecutively within each chapter. The first part is the chapter number followed by a dash and the consecutive page number. For example, page 3 of Chapter 2 is numbered 2-3.
- (5) <u>Appendices</u>. Appendices are found in the back of the manual. They provide reference information required for maintenance.
  - (a) Appendix A, References. This appendix contains other information you may need to do your job.
  - (b) Appendix B, Expendable/Durable Supplies and Materials List. This appendix contains information on expendable/durable items you need for maintenance.
  - (c) Appendix C, Illustrated List of Manufactured Items. This appendix contains information you need to make parts that are not procured.
- (6) <u>Index</u>. The index is located in the back of the manual. It lists topics in alphabetical order and references the paragraph numbers where information on the topic can be found.

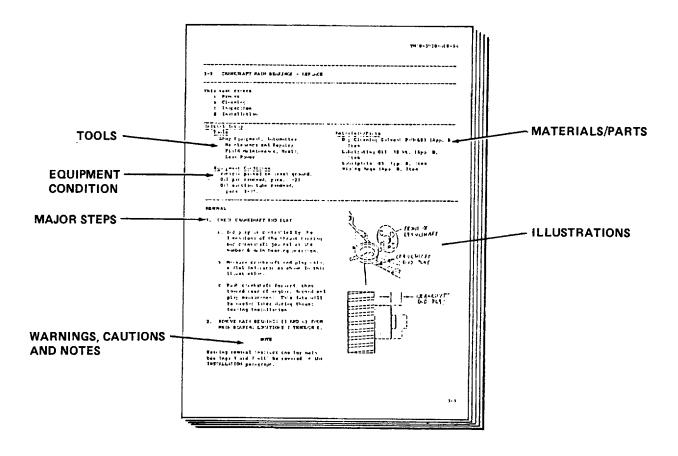
# 4. HOW TO FIND INFORMATION QUICKLY



- a. <u>Using the Front Cover</u>. The front cover of the manual has boxed titles for major topics. At the right side of each box is a blackened area. The blackened area matches black markings on the first page of that major topic in the manual. Fan the outer edge of the manual to find the topic material.
- b. <u>Using the Table of Contents</u>. The table of contents lists all chapters, appendices, sections and other important information in this manual and the page number where each starts.



- Using Chapter Indexes. On the first page of each chapter is an alphabetical summary listing of all
  paragraphs in that chapter and the page number where each can be found.
- d. <u>Using Paragraph Numbers and Titles</u>. Paragraph numbers include the chapter number. The paragraph number appears before the title of the paragraph title line. Paragraphs that are longer than one page will have the paragraph number and title continued at the top of each following page.



# 5. HOW TO USE THE TROUBLESHOOTING CHARTS

Troubleshooting is divided into two parts, electrical and mechanical. At the start of the section is an alphabetical summary listing of the paragraphs in that section and the page number where each can be found. Two of the paragraphs contain a symptom index, one for electrical and one for mechanical.

The symptom index lists common problems that you may have with the 6KVRRTFL and the page number where each can be found.

Each problem is followed by several tests or inspections that may indicate the cause of the problem. The tests or inspections are arranged from the most likely (1) to the least likely.

Each test or inspection is followed by step-by-step instructions needed to find the problem and the page number needed in the maintenance chapter to correct the problem.

# 6. HOW TO USE A PROCEDURE

Each procedure consists of two parts, an initial setup table and a task section. You must familiarize yourself with the entire maintenance procedures before beginning the maintenance task.

The initial setup table contains all or some of the following headings:

Tools - Describes tools needed to perform the procedure.

Test Equipment - Describes test equipment needed to perform the procedure.

Equipment Condition - Refers to other procedures that must be performed before attempting the procedure.

Materials/Parts - Describes miscellaneous materials and parts needed to perform the procedure.

<u>Personnel Required</u> - Describes quantity of personnel needed to perform the procedure.

# 7. HOW TO FIND CRITICAL INFORMATION

Critical information in maintenance chapters has been highlighted for experienced technicians so that they may scan a task quickly and pick out the information needed without reading the entire task. This way, the level of detail needed by low-experienced technicians will not interfere with critical information.

Information of interest to experienced users is highlighted with all capital letters. More detailed information is shown with lower case letters.

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# **CHAPTER 1 INTRODUCTION**

# Section I. GENERAL INFORMATION

# 1-1. SCOPE

- a. <u>Type of Manual.</u> This manual contains direct support (ds) and general support (gs) maintenance instructions for the 6KVRRTFL.
- b. Model Numbers and Equipment Name. The 6KVRRTFL, 6000 lb. Variable Reach Rough Terrain Forklift Truck. Equipped with Multiple Launch Rocket System (MLRS) lifting tool.
- c. <u>Purpose of Equipment.</u> The 6KVRRTFL is designed for loading and unloading Multiple Launch Rocket System (MLRS) pods and other munitions from transport vehicles and containers. The 6KVRRTFL is also designed for use as a standard rough terrain forklift.
- d. <u>Special Limitations on Equipment.</u> The 6KVRRTFL has no special limitations. Normal limitations such as travel speed, lift capacity, etc. are given in para. 1-8.

#### 1-2. MAINTENANCE FORMS AND RECORDS.

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS).

# 1-3. OFFICIAL NOMENCLATURE, NAMES, AND DESIGNATIONS.

Refer to the nomenclature cross-reference list below. This listing gives nomenclature cross-references used in this manual. The common name is in the left column and the official name is in the right.

# NOMENCLATURE CROSS-REFERENCE LIST

Common Name

6KVRRTFL

6000 lb. Variable Reach Rough Terrain Forklift Truck

MLRS

Multiple Launch Rocket System

# 1-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S).

If your 6KVRRTFL needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, U.S. Army Tank-Automotive Command, Attn: AMSTA-QRD, Warren, MI 48397-5000. We'll send you a reply.

# 1-5. EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST (EIR MD).

The quarterly Equipment Improvement Report and Maintenance Digest, TB 43-0001-39 series, contains valuable field information on the equipment covered in this manual. The information in the TB 43-0001-39 series is compiled from some of the Equipment Improvement Reports that you prepared on the vehicles covered in this manual. Many of these articles result from comments, suggestions, and improvement recommendations that you submitted to the EIR program. The TB 43-0001-39 series contains information on equipment improvements, minor alterations, proposed Modification Work Orders (MWOs) warranties (if applicable), actions taken on some of your DA Forms 2028-2 (Recommended Changes to Publications), and advance information will help you in doing your job better and will help in keeping you advised of the latest changes to this manual. Also refer to DA PAM 310-1 Consolidated Index of Army Publications and Blank Forms, and Appendix A, References, of this manual.

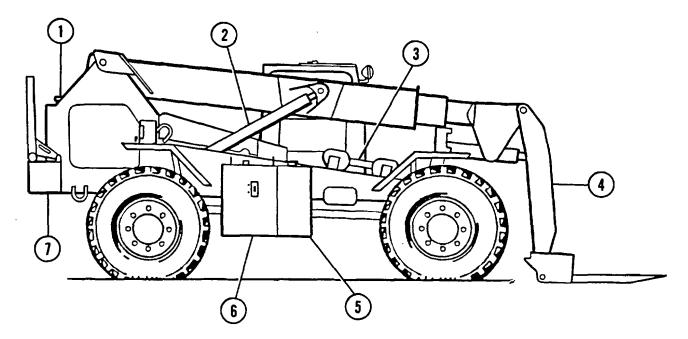
# 1-6. WARRANTY INFORMATION.

Refer to the Warranty Technical Bulletin TB10-3930-660-14.

#### Section II. EQUIPMENT DESCRIPTION AND DATA

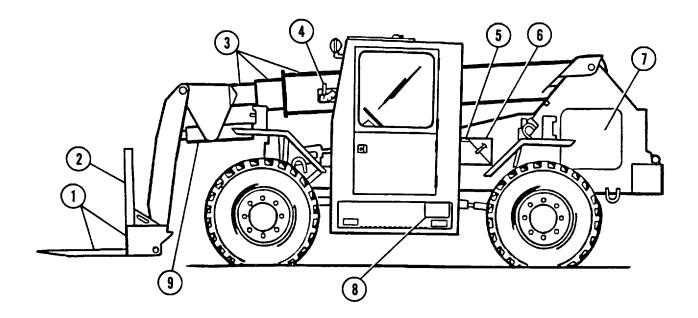
# 1-7. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

- a. Right Side View of the 6KVRRTFL.
  - (1) Radiator. Contains coolant which provides engine cooling.
  - Boom Hoist Cylinder. Raises and lowers the boom.
  - (3) MLRS Lifting Tool and Stop Tube (shown in storage position). The stop tube prevents the lifting tool from moving too far back on the forks and prevents the MLRS pod from contacting the frame or vehicle wheels when in the carry position.
  - (4) MLRS Attachment. This attachment is required for MLRS and forklift operations. The MLRS attachment can be raised to a horizontal position, creating a low profile and extended reach configuration. This configuration is useful in loading and unloading munitions from transport vehicles and containers.
  - (5) Fuel Tank. Contains diesel fuel for engine operation.
  - (6) Hydraulic Oil Reservoir. Contains hydraulic fluid for the hydraulic system.
  - (7) Frame and Counterweight. The frame is a heavy-duty design constructed of 1-3/16 inch thick steel plates. The frame is equipped with tie-down lugs meeting air transport specifications, tow lugs, a pintle hook, and a 3,600 lb. counterweight. The counterweight is removable so that axle loading can be adjusted to meet air transport requirements for some aircraft.
  - (8) Load Backrest (shown in storage position). Used to rest a load during non-MLRS operations. The backrest can be attached to the fork carriage and serves as a backstop or support for materials being carried on the forks.



# b. Left Side View of the 6KVRRTFL.

- (1) Forks and Carriage. Serves as an anchoring point of the forks. The fork carriage is also equipped with automatic fork leveling. Moving a switch will keep the forks level when raising or lowering the boom.
- (2) Load Backrest (shown in fork carriage position). Serves as a backstop or support for materials being carried on the forks.
- (3) Boom. The telescopic, three stage boom is constructed of welded high strength steel. The boom will retract or extend the reach and height of the forks.
- (4) Boom Angle Indicator. Shows the angle of the boom relative to the horizon.
- (5) NATO Slave Receptacle. Connection point for starting a disabled vehicle or for receiving starting assistance when disabled.
- (6) Battery Box. Holds the batteries which provide current for the electric system.
- (7) Engine. Provides the necessary power to drive the transmission. The engine also contains sending units for the Simplified Test Equipment for Internal Combustion Engines (STE/ICE) diagnostics.
- (8) Tool Box. Storage area for tools and basic issue items.
- (9) Attachment Hoist Cylinder. Moves the MLRS attachment forward and back.



# 1-8. EQUIPMENT DATA.

Table 1. Technical Specifications

ΕN	IGI	N	Ε
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Model Manufacturer Horsepower (@2, 500 RPM) Number of Cylinders Displacement Weight Maximum No Load RPM	
TRANSMISSION:	
ModelManufacturer PowershiftSpeed Range First GearSecond Gear Third Gear	
Weight	846 lbs.
AXLE AND BRAKES:	
Model (Front)	PSOC-205-HOB-206 Rockwell 1, 650 lbs. 27,100 lbs. 4,100 lbs.
Inner Boom Weight Intermediate Boom Weight Outer Boom Weight Boom Extend Cylinder Length (Carry Position) Maximum Width Height (Maximum) Wheelbase Track Width (Tread)	
CAPACITIES:	
Fuel Tank Cooling System Hydraulic Oil Reservoir Engine Crankcase	
MISCELLANEOUS: Lift (Maximum) Lift Height Boom Lift Angle (Maximum)	26 ft.

Maximum Reach from Load Center to Front Tires	24.16 ft.
Maximum Reach Below Grade	14.3 in.
Ground Clearance	15 ft. 4 in.
Frame Oscillation	9 degrees to the left or right
Fording Depth (Freshwater)	30 in.
Travel Speed (Maximum)	

# 1-9. SAFETY, CARE AND HANDLING.

Correct servicing procedures must be followed to ensure the safety of technicians working on the 6KVRRTFL. Refer to the safety summary of this manual (page e) for a list of safety precautions peculiar to this vehicle.

# **CHAPTER 2**

# **DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS**

# Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT

	Page
Common Tools and Equipment	2-1
Repair Parts	
Special Tools, TMDE and Support Equipment	2-1

# 2-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

# 2-2. SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT

For authorized special tools, TMDE and support equipment refer to the RPSTL and maintenance allocation chart (TM10-3930-660-20) pertaining to direct and general support maintenance for this equipment.

# 2-3. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list (RPSTL) TM10-3930-660-24P covering unit, direct and general support maintenance for this equipment.

#### Section II. TROUBLESHOOTING

	Page
Explanation of Columns	2-3
General Troubleshooting Instructions	
Symptom Index	
Troubleshooting	

#### 2-4. GENERAL TROUBLESHOOTING INSTRUCTIONS.

- a. The troubleshooting, Table 2-1, is divided into five different subsections listed below. A complete list of symptoms covered in Table 2-1 begins on page 2-6.
  - Engine This section lists common engine malfunctions which may be found during the operation or maintenance of the 6KVRRTFL.
  - (2) Powertrain This section lists common powertrain malfunctions which may be found during the operation or maintenance of the 6KVRRTFL.
  - (3) Steering System This section lists common steering system malfunctions which may be found during the operation or maintenance of the 6KVRRTFL. This section also covers the emergency steering pump hydraulic system.
  - (4) Braking System This section lists common braking system malfunctions which may be found during the operation or maintenance of the 6KVRRTFL. The brake hydraulic system is also covered in this section.
  - (5) Hydraulic System This section lists common hydraulic system malfunctions which may be found during the operation or maintenance of the 6KVRRTFL. This section covers all hydraulic troubleshooting except for the brake and steering hydraulic systems.
- b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or it is not corrected by the listed corrective actions, notify your supervisor.
- c. Each malfunction symptom, given for an individual component or system, is followed by a step(s) that should be taken to determine the cause and the corrective action that must be taken to remedy the problem.

# WARNING

Operation of a deadlined vehicle without preliminary inspection may cause further damage to a disabled component and possible injury to personnel.

- d. Do the easiest things first. Most problems are easily corrected. For example:
  - (1) Low power problems are generally caused by loose governor linkage or dirty fuel filters.

- (2) Excessive oil consumption is generally caused by leaky gaskets or loose line connections.
- (3) Always check the easiest and most obvious things first. This simple rule saves time and trouble.
- e. Double check before disassembly. The source of most engine problems can be traced to more than one part in the system. For example:
  - (1) Excessive fuel consumption may not be caused by the fuel pump alone. Instead, the trouble could be a clogged air cleaner reducing air inflow or a restricted exhaust passage, causing abnormally high back pressure.
  - (2) Engines very often are disassembled in search of a complaint and the real evidence of the problem is destroyed. Check again to be sure an easier solution to the problem has not been overlooked.
  - (3) Check all tags, service request forms, and vehicle logbook for repair history. This may help lead to the source of problems.
- f. Before attempting to correct a problem, diagnose the cause of the problem. Do not allow the same failure to occur again.

#### 2-5. EXPLANATION OF COLUMNS.

- a. Malfunction. Visual or operational indication that something is wrong with the 6KVRRTFL.
- b. <u>Test/Inspection.</u> Procedure to isolate the problem to a component or system.
- c. <u>Corrective Action</u> Procedure to correct problem.

# 2-6. SYMPTOM INDEX.

Refer to Table 2-1 for troubleshooting procedures, and use the symptom index below to quickly locate a particular fault or malfunction.

# TROUBLESHOOTING SYMPTOM INDEX

MALFUNCT NO.	ION MALFUNCTION	PAGE
	ENGINE	
1	Engine will not crank	2-6
2	Engine cranks but will not start	
3	Rough idle (irregular firing or engine shaking)	
4	Lubricating oil pressure too low	
5	Lubricating oil pressure too high	
6	Excessive vibration	
	POWERTRAIN	
7	Low oil pressure from torque converter	2-7
	STEERING SYSTEM	
8	Steering difficulty; vehicle pulls on straight froward driving or tends to go	
	straight when making turns	
9	Front differential is binding in turns	
10	Excessive driveline noise	
11	Front differential has grinding noises	2-8
12	Sluggish re-engagement of front differential	
	clutch assemblies	2-9
13	Erratic operation of front differential;	
	premature wear or failure of parts	2-9
14	Emergency steering pump will not hold pressure	
	in dis. line	2-10
15	Emergency steering pump will not develop full	
	pressure or flow	2-10
	BRAKING SYSTEM	
16	Brakes won't release	
17	Insufficient brakes	
18	Brakes will not release completely	
19	Excessive braking	2-11
20	Braking accumulator charging cycle repeats frequently when brakes are not being used	2-11
21	Brake accumulator charges frequently while brakes	
	are being held	2-12
22	Brake accumulator starts to charge but doesn't	
	reach high limit	2-12
23	Brake accumulator charging time too long	
24	Brake accumulator fails to start charging	
25	Very rapid cycling of brake valve	

# TROUBLESHOOTING SYMPTOM INDEX

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NO.	MALFUNCTION	PAGE
	HYDRAULIC SYSTEM	
26	MLRS attachment or main control relief valves not seating	2-13
27	Leakage found between sections of MLRS attachment or main control valves	2-13
28	Spools binding in MLRS attachment or main control valves	2-13
29	Excessive pressure in MLRS attachment or main control valves during neutral position	2-13
30	Sticking plungers of MLRS attachment or main control valves	2-13
31	Leaking seals of MLRS attachment or main control valves	2-14
32	Detent control fails to hold inside MLRS attachment or main control valves	2-14
33	The MLRS attachment or main control valve will not hold load	2-15
34	The MLRS attachment or main control valve drops load when plunger moves from neutral	2-15
35	Erratic pressure found in MLRS attachment or main control relief valves	2-15
36	Relief valve leakage found in MLRS attachment or main control valves	2-15

# MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

#### **ENGINE**

# 1. ENGINE WILL NOT CRANK

- Step 1. Perform the electrical system troubleshooting, TM10-3930-660-20.
- Step 2. Check for engine seizure.
  - a. Remove fuel injection nozzles, para. 4-3.
  - b. Try to turn crankshaft manually.
  - c. If crankshaft will not rotate, go to step 3.
  - d. If crankshaft turns and liquid is discharged from nozzle holes, check if liquid is coolant or fuel.
  - e. If liquid is coolant, replace the cylinder head, para. 3-7.
  - f. If liquid is fuel, test fuel injection nozzles, para. 4-3. Replace defective nozzle(s), para. 4-3.
- Step 3. If crankshaft will not turn, engine has internal damage and requires internal repair.

Remove engine, para. 3-3. Disassemble and check for bearing seizure, para. 3-9 or piston seizure, para. 3-14. Replace components as required.

#### 2. ENGINE CRANKS BUT WILL NOT START

Check for possible dirty or damaged fuel injection nozzles.

Replace/repair fuel injection nozzles, if necessary, para. 4-3.

# 3. ROUGH IDLE (irregularly firing or engine shaking)

Check for overtightened, damaged, or loose engine mounts.

Tighten, loosen, or replace mounts as required, para. 3-4.

# 4. LUBRICATING OIL PRESSURE TOO LOW

Check relief valve (stuck open).

Replace relief valve, para. 3-23.

# **MALFUNCTION**

# TEST OR INSPECTION CORRECTIVE ACTION

#### 5. LUBRICATING OIL PRESSURE TOO HIGH

Check relief valve (stuck closed)

Replace relief valve, para. 3-23.

#### 6. EXCESSIVE VIBRATION

Check for loose, overtightened, or damaged engine mounts and vibration damper.

Replace damaged engine mounts, para. 3-4, or vibration damper, para. 3-11.

#### **POWERTRAIN**

#### 7. LOW OIL PRESSURE FROM TORQUE CONVERTER

Check operation of transmission oil pump.

Replace or repair transmission oil pump, para. 7-9.

#### STEERING SYSTEM

# 8. STEERING DIFFICULTY; VEHICLE PULLS ON STRAIGHT FORWARD DRIVING OR TENDS TO GO STRAIGHT WHEN MAKING TURNS

Step 1. Check front differential for proper installation or component failure.

Remove, repair, or install front differential, para. 8-5.

Step 2. Check front axle for breakage.

Replace front axle shaft, para. 8-3.

# 9. FRONT DIFFERENTIAL IS BINDING IN TURNS

Step 1. Check front differential for proper installation or component failure.

Remove, repair, or install front differential, para. 8-5.

Step 2. Check front axle for breakage.

Replace front axle shaft, para. 8-3.

Step 3. Check front axle and differential housing for bends.

Replace front axle, para. 8-3 or front differential housing, para. 8-5.

Step 4. Check for dirt or debris in the front differential housing.

Disassemble, clean, and assemble front differential housing, para. 8-5.

Step 5. Check for improper assembly of front differential.

Repair front differential, para. 8-5.

#### 10. EXCESSIVE DRIVELINE NOISE

Step 1. Check front differential for proper installation or component failure.

Remove, repair, or install front differential, para. 8-5.

Step 2. Check front axle for breakage.

Replace front axle shaft, para. 8-3.

Step 3. Check front axle and differential housing for bends.

Replace front axle, para. 8-3 or front differential housing, para. 8-5.

Step 4. Check wheels for proper alignment.

Align wheels, TM10-3930-660-10.

Step 5. Check for dirt or debris in the front differential housing.

Disassemble, clean, and assemble front differential housing, para. 8-5.

Step 6. Check for improper assembly of front differential.

Repair front differential, para. 8-5.

#### 11. FRONT DIFFERENTIAL HAS GRINDING NOISES

Step 1. Check front differential for proper installation or component failure.

Remove, repair, or install front differential, para. 8-5.

Step 2. Check front axle and differential housing for bends.

Replace front axle, para. 8-3 or front differential housing, para. 8-5.

Step 3. Check front axle for breakage.

Replace front axle shaft, para. 8-3.

Step 4. Check ring gear, pinion gear, bearings and seals for defects or wear.

Repair front differential, para. 8-5.

Step 5. Check for dirt or debris in the front differential housing.

Disassemble, clean, and assemble front differential housing, para. 8-5.

Step 6. Check for improper assembly of front differential.

Repair front differential, para. 8-5.

Step 7. Check front differential ring and pinion adjustment.

Adjust backlash of ring gear, para. 8-5.

Step 8. Check for worn driveline parts.

Replace or repair transmission gears, para. 8-5 and U-joints, 8-3 as necessary.

# 12. SLUGGISH RE-ENGAGEMENT OF FRONT DIFFERENTIAL CLUTCH ASSEMBLIES

Step 1. Check for dirt or debris in the front differential housing.

Disassemble, clean, and assemble front differential housing, para. 8-5.

Step 2. Check for improper assembly of front differential.

Repair front differential, para. 8-5.

Step 3. Check lubricant used on axles.

Change axle oil for ambient temperature, TM10-3930-660-20.

# 13. ERRATIC OPERATION OF FRONT DIFFERENTIAL; PREMATURE WEAR OR FAILURE OF PARTS

Step 1. Check front differential for proper installation or component failure.

Remove, repair, or install front differential, para. 8-5.

Step 2. Check front axle for breakage.

Replace front axle shaft, para. 8-3.

Step 3. Check front axle and differential housing for bends.

Replace front axle, para. 8-3 or front differential housing, para. 8-5.

Step 4. Check for dirt or debris in the front differential housing.

Disassemble, clean, and assemble front differential housing, para. 8-5.

Step 5. Check for improper assembly of front differential.

Repair front differential, para. 8-5.

Step 6. Check ring gear, pinion gear, bearings and seals for defects or wear.

Repair front differential, para. 8-5.

Step 7. Check front differential ring and pinion adjustment.

Adjust backlash of ring gear, para. 8-5.

Step 8. Check for worn driveline parts.

Replace or repair transmission gears, para. 8-5 and U-joints, 8-3 as necessary.

# 14. EMERGENCY STEERING PUMP WILL NOT HOLD PRESSURE IN DISCHARGE LINE

Replace check valve to determine if faulty.

Replace check valve, para. 12-4.

#### 15. EMERGENCY STEERING PUMP WILL NOT DEVELOP FULL PRESSURE OR FLOW

Replace check valve to determine if faulty.

Replace check valve, para. 12-4.

#### **MALFUNCTION**

# TEST OR INSPECTION CORRECTIVE ACTION

#### **BRAKING SYSTEM**

#### 16. BRAKES WON'T RELEASE

Step 1. Check brake valve for ball valve damage.

Repair brake valve, para. 10-4.

Step 2. Check for binding piston in brake valve.

Repair brake valve, para. 10-4.

#### 17. INSUFFICIENT BRAKES

Step 1. Check pressure regulating spring in brake valve for damage.

Repair brake valve, para. 10-4.

Step 2. Check boot on brake valve for cuts.

Repair brake valve, para. 10-4.

#### 18. BRAKES WILL NOT RELEASE COMPLETELY

Check piston in brake valve for sticking.

Repair brake valve, para. 10-4.

#### 19. EXCESSIVE BRAKING

Check for quantity of shims in brake valve.

Repair brake valve, para. 10-4.

# 20. BRAKE ACCUMULATOR CHARGING CYCLE REPEATS FREQUENTLY WHEN BRAKES ARE NOT BEING USED

Step 1. Check brake valve poppet for leakage.

Repair brake valve, para. 10-4.

Step 2. Check brake valve seals and O-rings for leakage.

Repair brake valve, para. 10-4.

Step 3. Check seating of ball valve in brake valve.

Repair brake valve, para. 10-4.

Step 4. Check pilot valve for leakage of brake valve.

Repair brake valve, para. 10-4.

#### 21. BRAKE ACCUMULATOR CHARGES FREQUENTLY WHILE BRAKES ARE BEING HELD

Step 1. Check for seal damage in brake valve.

Repair brake valve, para. 10-4.

Step 2. Check for seat damage on piston in brake valve.

Repair brake valve, para. 10-4.

#### 22. BRAKE ACCUMULATOR STARTS TO CHARGE BUT DOESN'T REACH HIGH LIMIT

Check for seal damage in brake valve.

Repair brake valve, para. 10-4.

#### 23. BRAKE ACCUMULATOR CHARGING TIME TOO LONG

Step 1. Check for broken spring in brake valve.

Repair brake valve, para. 10-4.

Step 2. Check for dirt in filter of brake valve.

Repair brake valve, para. 10-4.

Step 3. Check for sticking poppet in brake valve.

Repair brake valve, para. 10-4.

#### 24. BRAKE ACCUMULATOR FAILS TO START CHARGING

Step 1. Check for broken springs in brake valve.

Repair brake valve, para. 10-4.

Step 2. Check for seal damage in brake valve.

Repair brake valve, para. 10-4.

Step 3. Check for dirt in filter of brake valve.

Repair brake valve, para. 10-4.

# 25. VERY RAPID CYCLING OF BRAKE VALVE

Step 1. Check pilot valve for wear in brake valve.

Repair brake valve, para. 10-4.

#### **HYDRAULIC SYSTEM**

#### 26. MLRS ATTACIIMENT OR MAIN CONTROL RELIEF VALVES NOT SEATING

Step 1. Inspect relief valve(s) for contamination.

Remove and disassemble relief valve(s) (para. 16-5).

# 27. LEAKAGE FOUND BETWEEN SECTIONS OF MLRS ATTACEIMKNT OR E&IN CONTROL VALVES

Step 1. Inspect seals.

Disassemble valve(s) and replace seals, para. 16-4 and 16-5.

Step 2. Check torque of tie rods on MLRS and main control valves.

Torque tie rods, para. 16-4 and 16-5.

#### 28. SPOOLS BINDING IN MLRS ATTACHMENT OR MAIN CONTROL VALVES

Check movement of spools.

Repair valve(s), para. 16-4 or 16-5.

#### 29. EXCESSIVE PRESSURE IN MLRS ATTACHMENT OR MAIN CONTROL VALVES DURING NEUTRAL POSITION

Check to see that spools are centered.

Repair valve(s), para. 16-4 or 16-5.

#### 30. STICKING PLINERS OF MLRS ATTACHMENT OR MAIN CONTROL VALVES

Step 1. Check valve for warpage from mounting.

Repair valve(s), para. 16-4 or 16-5.

Step 2. Check plunger for bends.

Repair valve(s), para. 16-4 or 16-5.

Step 3. Check return spring for damage.

Repair valve(s), para. 16-4 or 16-5.

Step 4. Check spring or detent cap for binding.

Loosen cap, center and tighten parts, para. 16-4 or 16-5.

Step 5. Check valve for contamination.

Clean or repair valve, para. 16-4 or 16-5.

Step 6. Check plunger cap for oil.

Replace seals, para. 16-4 or 16-5.

#### 31. LEAKING SEALS OF MLRS ATACHMENTOR MAIN CONTROL VALVES

Step 1. Check for paint or dirt on or under seals.

Replace seals, para. 16-4 or 16-5.

Step 2. Check for scored plunger.

Repair valve, para. 16-4 or 16-5.

Step 3. Check for loose seal plates.

Repair valve, para. 16-4 or 16-5.

Step 4. Check for seal damage.

Repair valve, para. 16-4 or 16-5.

#### 32. DETENT CONTROL FAILS TO HOLD INSIDE MLRS ATTACHMENT OR MIN CONTROL VALVES

Step 1. Check detent cam for wear.

Repair valve, para. 16-4 or 16-5.

Step 2. Check spring or ball for damage or defects.

Repair valve, para. 16-4 or 16-5.

#### 33. TFIE NLRS ATTACHMENT OR MAIN CONTROL VALVE WILL NOT HOLD LOAD

Check port relief valve for hold.

Remove relief valve and clean, para. 16-4 or 16-5.

#### 34. THE MLRS ATTACHMENT OR MAIN CONTROL VALVE DROPS LOAD WHPLUNGER MOVES FR NEUTRAL

Step 1. Check for dirt in check valve.

Repair and clean valve, para. 16-4 or 16-5.

Step 2. Check for scored check valve poppet or seat.

Repair valve, para. 16-4 or 16-5.

#### 35. ERRATIC PRESSURE FOUND IN ILRS ATTACEHENT OR MAIN ONTROL RELIEF VALVES

Check poppet seat for sticking or damage.

Repair valve, para. 16-4 or 16-5.

#### 36. RELIEF VALVE LEAKAGE FOUND IN LRS ATTACE/ENT OR IAIN CONTROL VALVES

Step 1. Check for part damage or wear.

Repair valve, para. 16-4 or 16-5.

Step 2. Check for sticking parts.

Repair valve, para. 16-4 or 16-5.

2-15/(2-16 Blank)

#### Section III. GENERAL MAINTENANCE INSTRUCTIONS

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Cleaning Instructions	2-18
General Information	2-17
Inspection Instructions	2-20
Painting	2-24
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Scope	2-17

#### 2-7. SCOPE.

These general maintenance instructions contain general shop practices and specific methods you must be familiar with to properly maintain the 6KVRRTFL. You should read and understand these practices and methods before starting maintenance tasks on the 6KVRRTFL.

#### 2-8 WORK SAFETY.

- a. Before starting a task, think about the risks and hazards to your safety as well as others. Wear protective equipment such as safety goggles or lenses, safety shoes, rubber apron or gloves. Protect yourself against injury.
- b. When lifting heavy parts, have someone help you. Ensure that lifting equipment is working properly, that it is suitable for the task assigned, and is secured against slipping.
- c. Always use power tools carefully.

#### 2-9. GENERAL INFORMATION.

- a. Before beginning a task, find out how much repair, modification, or replacement is needed to fix the equipment as described in this manual. Sometimes the reason for equipment failure can be seen right away and complete teardown is not necessary to repair or replace damaged or broken parts.
- b. All tags and forms attached to the equipment must be checked to learn the reason for removal from service. Check all Modification Work Orders (MWO) and Technical Bulletins (TB) for equipment changes or broken parts.
- c. In some cases a part may be damaged by removal. If the part appears to be good, and other parts behind it are not defective, leave it on and continue the procedure. Here are a few simple rules:
  - (1) Do not take out dowel pins or studs unless loose, bent, broken or otherwise damaged.
  - (2) Do not pull bearings or bushings unless damaged. If you must get at parts behind them, pull out bearings or bushings carefully.
- (3) Replace all gaskets, seals, and preformed packings.

#### 2-10.CLEANING INSTRUCTIONS.

#### a. General.

- (1) The cleaning instructions will be the same for the majority of parts and components that make up the 6KVRRTFL.
- (2) The importance of cleaning must be thoroughly understood by maintenance personnel. Great care and effort are required in cleaning. Dirt and foreign material are a constant threat to satisfactory maintenance. The following should apply to all cleaning, inspection, repair and assembly operations.
  - (a) Clean all parts before inspection, after repair and before assembly.
  - (b) Hands should be kept free of any accumulation of grease, which can collect dust, dirt or grit.
  - (c) After cleaning, all parts should be covered or wrapped to protect them from dust and dirt. Parts that are subject to rust should be lightly oiled.
- (3) Observe the following precautions during all cleaning operations:

#### WARNING

P-D-680 (Type II) is a flammable solvent that is potentially dangerous to personnel. Keep away from heat, sparks or open flame. Flash point of solvent is 138°F. Use only in a well ventilated area. Inhaling vapors over a period of time can cause headache and drowsiness. Use gloves to prevent irritation or inflammation of the skin. Solvent absorbed through the skin can result in internal disorders. If contact occurs, wash the affected area with water for 15 minutes. For eyes, flush with water and then seek immediate medical attention.

#### **WARNING**

Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.

#### WARNING

Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.

#### WARNING

Particles blown by compressed air are hazardous. Make certain the airstream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.

#### b. External Engine Cleaning.

- (1) Protect all electrical equipment that could be damaged by the steam or moisture before steam cleaning.
- (2) Cover all openings before steam cleaning.
- (3) After cleaning, dry and apply a light coat of oil to all parts subject to rust.
- (4) Blow out all tapped (threaded) holes with compressed air to remove dirt and cleaning fluid.

#### c. <u>Disassembled Parts Cleaning</u>.

- (1) Place all disassembled parts in wire baskets for cleaning.
- (2) Dry and cover all cleaned parts.
- (3) Place parts on or in "racks" and hold for inspection or repair.
- (4) All parts subject to rusting must be lightly oiled and wrapped.
- (5) Keep all related parts and components together. Do not mix parts.

#### d. Castings.

- (1) Clean inner and outer surfaces of castings and all areas subject to grease and oil with cleaning solvents. Refer to TM9-247.
- (2) Use a stiff brush to remove sludge and gum deposits.
- (3) Blow out all tapped (threaded) holes with compressed air to remove dirt and cleaning fluid.
- e. <u>Oil Passages</u>. Particular attention must be given to all oil passages in castings and machined parts. Oil passages must be clean and free of any obstructions.
  - (1) Clean passages with wire probes to break up any sludge or gum deposits.
  - (2) Wash passages by flushing with any solvents. Refer to TM9-247.
  - (3) Dry passages with compressed air.
- f. Oil Seals, Electrical Cables, and Flexible Hoses.

#### **CAUTION**

Washing oil seals, electrical cables and flexible hoses with dry cleaning solvents or mineral spirits will cause serious damage or destroy the material.

(1) Wash electrical cables and flexible hose with water and mild soap solution and wipe dry.

(2) Oil seals are generally damaged during removal, so cleaning will not be necessary since new seals will be used in assembly.

#### g. Bearings.

- (1) Bearings require special cleaning. After removing surface oil and gum deposits, place bearings in hot oil (140 F) to loosen congealed oil and grease. Wipe all bearings dry. Do not use compressed air. After cleaning, coat bearings with oil, wrap in paper, and hold for inspection.
- (2) Refer to TM9-214 for information and care of bearings.

#### h. Machine Tooled Parts.

- (1) Clean machine tooled parts with dry cleaning solvent (P-D-680).
- (2) Dry surfaces with compressed air.

#### i. Machined Surfaces.

- (1) Clean machined surfaces with dry cleaning solvent (P-D-680).
- (2) Dry surfaces with compressed air.

#### j. Mated Surfaces.

- (1) Remove old gasket and/or sealing compound using wire brush and dry cleaning solvent (P-D-680).
- (2) Lightly oil and wrap all parts subject to rust before storing.
- k. Rusted Surfaces. Clean all rusted surfaces using wire brush and crocus cloth.
- I. Oil Bathed Internal Parts. Wipe oil bathed internal parts clean with lint free cloth.
- m. Air Actuated Internal Parts. Wipe air actuated internal parts clean with lint free cloth.
- n. Externally Exposed Parts. Wash these parts with soap and water. Rinse thoroughly and air dry.

#### 2-11.INSPECTION INSTRUCTIONS.

- a. <u>General</u>. All components and parts must be carefully checked to determine if they are serviceable for reuse, if they can be repaired, or if they must be scrapped.
- b. Drilled and Tapped (Threaded) Holes.
  - (1) Inspect for wear, distortion (stretching), cracks or any other damage in or around holes.
  - (2) Inspect threaded areas for wear, distortion or evidence of cross-threading.

- (3) Mark all damaged areas for repair or replacement.
- c. Metal Lines, Flexible Lines (Hoses) and Fittings.
  - (1) Inspect lines for sharp kinks, cracks, bends or dents.
  - (2) Inspect flexible lines for fraying, evidence of leakage or loose fittings or connectors.
  - (3) Check all fittings and connectors for thread damage. Check for hex heads that are worn or rounded by poorly fitting wrenches.
  - (4) Mark all damaged material for repair or replacement.

#### d. Castings.

- (1) Inspect all ferrous and nonferrous castings for cracks using a magnifying glass and strong light.
- (2) Refer to MIL-I-6866, Inspection, Liquid Penetrant Methods, and MIL-I-6868, Inspection Process, Magnetic Particles.
- (3) Particularly check areas around studs, pipe plugs, threaded inserts, and sharp corners. Replace all cracked castings.
- (4) Inspect machined surfaces for nicks, burrs, or raised metal. Mark damaged areas for repair or replacement.
- (5) Inspect all pipe plugs, pipe plug openings, screws, and screw openings for damaged or stripped threads.
- (6) Check all gasket mating surfaces, flanges on housings, and supports for warpage with a straightedge or surface plate. Inspect mating flanges for discolorations that may indicate persistent oil leakage.
- (7) Check all castings for conformance to applicable repair standards.
- e. <u>Bearings</u>. Refer to TM9-214 for inspection of bearings. Check all bearings for conformance to applicable repair standards.
- f. Studs. Bolts and Screws. Replace if threads are damaged, bent, loose or stretched.
- g. Gears.

#### NOTE

When gear teeth wear limits are not established, good judgment is required to determine if gear replacement is necessary.

- (1) Inspect all gears for cracks using a magnifying glass and strong light. No cracks are permissible.
- (2) Inspect gear teeth for wear, sharp fins, burrs, and galled or pitted surfaces.

- (3) Check keyway slots for wear or damage.
- h. Bushings and Bushing Type Bearings.
  - (1) Check all bushings and bushing type bearings for secure fit, evidence of overheating, wear, burrs, nicks and out-of-round condition. Replace as necessary.
  - (2) Check for dirt in lubrication holes or grooves. Holes and grooves must be clean and free from damage.
- i. Oil Seals. Oil seals are mandatory replacement items.
- j. Core Hole Expansion Plugs. Inspect for leakage. Replace plugs when leakage is present.
- k. Machine Tooled Parts. Inspect for cracks, breaks, elongated holes, wear and chips. Replace any damaged parts.
  - 1. Machined Surfaces. Inspect for cracks, evidence of wear, galled or pitted surface, burrs, nicks, and scratches.
- m. Mated Surfaces. Inspect for remains of old gasket, seal, secure fit, pitting and evidence of leakage.
- n. Rusted Surfaces. Inspect for pitting, holes and severe damage.
- o. Oil Bathed Internal Parts. Inspect for cracks, nicks, burrs, evidence of overheating and wear.
- p. Air Actuated Internal Parts. Inspect for cracks, nicks, burrs, evidence of overheating and wear.
- q. Externally Exposed Parts. Inspect for breaks, cracks, rust damage and wear.
- r. Springs. Inspect for broken, collapsed and twisted coils.

#### 2-12.REPAIR INSTRUCTIONS.

a. <u>General</u>. Any repair procedure peculiar to a specific part or component is covered in the section or paragraph relating to that item. After repair, clean all parts thoroughly to prevent dirt, metal chips or other foreign material from entering any working parts.

#### CAUTION

Repaired items must be thoroughly cleaned to remove metal chips and abrasives to prevent them from entering working parts of the 6KVRRTFL.

#### b. Castings.

(1) All cracked castings will be replaced.

- (2) Only minor repairs to machined surfaces, flanges and gasket mating surfaces are permitted. Remove minor nicks, burrs and scratches with:
  - (a) Fine mill file.
  - (b) Crocus cloth dipped in cleaning solvent.
  - (c) Lapping across a surface plate.
- (3) Remachining of machined surfaces to repair damage, warpage or uneven surfaces is not permitted. Replace castings.
- (4) Repair damaged threaded pipe plug or screw threads with a tap. Repair oversize holes with threaded inserts.
- c. <u>Bearings</u>. Refer to TM9-214 for repair of bearings.
- d. <u>Studs</u>. Replace all bent and stretched studs. Repair minor thread damage with a thread die. Replace studs having stripped or damaged threads as outlined below:
  - (1) Remove using a stud remover. Back studs out slowly to avoid heat buildup and seizure that can cause stud to break off.
  - (2) If studs break off too short to use a stud remover, use a stud extractor to remove or use a "welding method".

#### **CAUTION**

Refer to TM9-237, Welding Instructions, to avoid damage to castings if welding method is used.

- (3) Broken studs can be removed by welding bar stock or a nut to stud and removing with wrench.
- (4) Install replacement stud slowly to prevent heat buildup and snapping off.
- e. Gears.
  - (1) Remove gears using pullers.
  - (2) Only minor repairs to gears are permitted. Remove minor nicks, burrs or scratches on gear teeth with:
    - (a) Fine mill file.
    - (b) Crocus cloth dipped in cleaning solvent.
  - (3) If keyways are worn or enlarged, replace gear.
- f. <u>Bushings and Bushing Type Bearings</u>. When bushings and bushing type bearings seize to a shaft and spin in the bore, the associated part must also be replaced.

# g. Oil Seals.

- (1) Remove oil seals by pressing or prying out, being careful not to damage casting or adapter bore.
- (2) Always install new seal in bore using proper seal replacing tool.

# 2-13. PAINTING.

Upon installation, restored parts must be painted per TB 43-0209.

#### **CHAPTER 3**

#### **ENGINE SYSTEM MAINTENANCE**

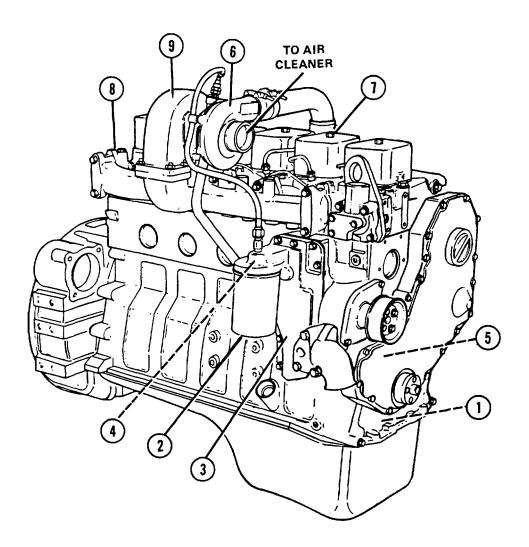
#### Section I. DESCRIPTION AND DATA

#### 3-1. GENERAL.

This chapter covers maintenance procedures for the engine system components, as well as principles of operation.

# 3-2. PRINCIPLES OF OPERATION.

a. <u>Construction</u>. Engine is a six cylinder, inline, four-stroke-cycle, turbocharged, fuel injected, liquid cooled diesel. A 4.02 inch bore and a 4.72 inch stroke produce a piston displacement of 359 cu. inch. Engine firing order is 1, 5, 3, 6, 2, 4 and engine rotation is clockwise, as viewed from front (fan) end. Cylinder number 1 is closest to fan. Rated horsepower is 152 hp, at engine speed of 2500 rpm. Maximum rated torque is 400 ft. lbs. at engine speed of 1500 rpm.



- b. Fuel System. Engine fuel system is described in para. 4-2.
- c. Cooling System. Engine cooling system is described in para. 5-2.
- d. <u>Lubrication System</u>. Engine lubricating oil is forced through various internal passages by an internally mounted, gear type pump (1). Oil is cleaned by a disposable filter cartridge (2) and is cooled by engine coolant flow through a cooler (3) mounted to the side of the engine. A pressure operated bypass valve (4) is incorporated to provide continued oil flow around filter in the event filter becomes clogged. A differential pressure of 20 psi will open filter bypass valve. A pressure regulating valve (5), located in the front of the engine, is designed to open at a pressure of 60 psi to protect pump and other system components against excessive pressures.
- e. <u>Air Intake System</u>. Air intake system includes an air cleaner, turbocharger (6), intake manifold (7) and connecting piping. Purpose of air intake system is to provide a supply of clean, pressurized air for fuel combustion in the engine cylinders. Turbocharger rotation draws air through the air cleaner, where most airborne contaminants are removed, and forces this air, under pressure into the intake manifold. From the intake manifold, air is distributed to the cylinders through timing action of the intake valves.
- f. <u>Exhaust System</u>. Exhaust system includes exhaust manifold (8), turbocharger turbine (9), exhaust piping and muffler. Exhaust gases are directed against the turbine blades, causing turbine to rotate at high speed. Exhaust gases leaving turbocharger pass through the muffler, which reduces level of exhaust noises.

# Section II. ENGINE SYSETI MAINTENANCE PROCEDURES

# **ENGINE SYSTEM MAINTENANCE TASK SUMMARY**

TASK PARA.	PROCEDURES	PAGE NO.
3-3	Engine Assembly - Replace	3-4
3-4	Engine Mounts - Replace	3-25
3-5	Engine Lifting Brackets - Replace	3-29
3-6	Cylinder Block - Replace	3-30
3-7	Cylinder Head Assembly - Replace/Repair	3-36
3-8	Crankshaft - Replace/Repair	3-51
3-9	Crankshaft Main Bearings - Replace	3-67
3-10.1	Crankshaft Front Seal - Replace	3-80
3-10.2	Crankshaft Rear Seal - Replace	3-82
3-11	Crankshaft Vibration Damper - Replace	3-84
3-12	Flywheel - Replace	3-85
3-13	Flywheel Housing and Cover - Replace/Repair	3-90
3-14	Pistons, Piston Pins and Rings - Replace	3-94
3-15	Connecting Rods and Bearings - Replace	3-99
3-16	Rocker Arm Assembly - Replace/Repair	3-105
3-17	Valve Tappets - Replace	3-109
3-18	Camshaft and Timing Gears - Replace	3-111
3-19	Front Housing and Cover - Replace/Repair	3-117
3-19.1	Push Rod Cover - Replace	3-122
3-20	Oil Pan - Replace	3-123
3-21	Engine Oil Pump Inlet Tube - Replace	3-124
3-22	Engine Oil Pump - Replace	3-126
3-23	Engine Oil Cooler and Filter Base - Replace	3-130

#### 3-3. ENGINE ASSEMBLY - REPLACE

#### This task covers:

- a. Removal
- b. Installation

#### Initial Setup

#### Tools

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Forklift Truck (capacity 2000 lb.)

Engine Stand (capacity 2000 lb.)

Lifting Chain (capacity 2000 lb.)

#### **Equipment Condition**

Engine oil drained, L010-3930-660-12. Radiator removed, TM10-3930-660-20. Air cleaner removed, TMIO-3930-660-20. Muffler removed, TM10-3930-660-20. Transmission cover removed, TM10-3930-660-20.

#### Materials/Parts

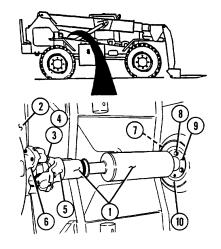
Cotter Pin (26)
Engine Oil (App. B, Item 35)
Locknut (38, 48, 52)
Lockwashers (4, 44, 46)
Loctite 271 (App. B, Item 43)
Rubber Mount (56, 57)
Tags (App. B, Item 52)
Tie Wraps (App. B, Item 54)

Personnel Required
Two Personnel

#### **REMOVAL**

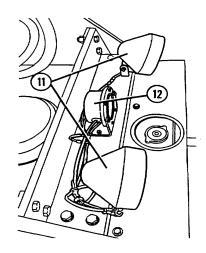
- 1. NOTE TIE WRAP LOCATIONS, THEN CUT AND DISCARD ALL TIE WRAPS THAT SECURE ELECTRICAL WIRING, TUBING, AND HOSES TO THE ENGINE.
- 2. REMOVE DRIVE SHAFT ASSEMBLY (1) FROM TRANSMISSION (2).

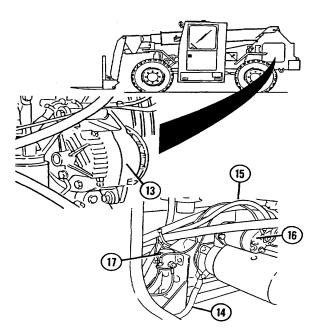
Remove four capscrews (3) and four lockwashers (4) securing universal joint (5) of shaft assembly (1) to input yoke (6) of transmission (2). Discard lockwashers (4).



#### 3-3. ENGINE ASSEMBLY - REPLACE (Cont'd)

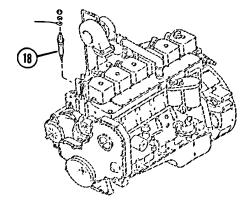
- 3. REMOVE DRIVE SHAFT ASSEMBLY (1) FROM ENGINE DAMPENER (7).
  - a. Remove three capscrews (8) from engine coupling (9).
  - b. Temporarily install two of the capscrews (8) removed in step 3a into two jacking holes (10) of engine coupling (9).
  - c. Tighten two capscrews (8) evenly until shaft assembly (1) and engine coupling (9) separate from engine dampener (7).
  - d. Remove coupling (9) and shaft assembly (1) from vehicle as an assembly.
- 4. NOTE ROUTING OF ENGINE AND STE/ICE WIRING HARNESSES. TAG AND DISCONNECT:
  - a. Electric leads from rear flood light (11) and back-up alarm (12).
  - b. Electrical leads nos. N and 60 from 'BAT' terminal and electric lead no. P from '1' terminal of alternator (13).
  - c. Battery ground cable (14) and wire no. M from starter mounting capscrew.
  - d. Battery positive cable (15) and wire nos. 39, T, and two wires nos. 60 from starter solenoid terminal 'BAT'.
  - e. Wiring harness leads nos. S and 38 from starter solenoid (16) terminal 'S'.
  - f. Electrical leads from starter relay (17): lead no. 39 from large rear terminal, lead no. 38 from large front terminal, and lead no. 4A from rear small terminal.



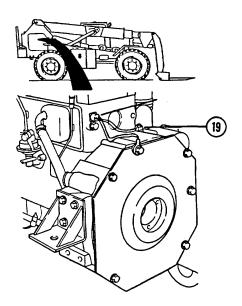


# 3-3. ENGINE ASSEMBLY - REPLACE (Cont'd)

g. Electrical lead no. 15 from water temperature sender (18).



h. Ether start thermostat connector (19).

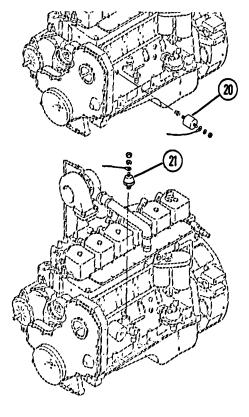


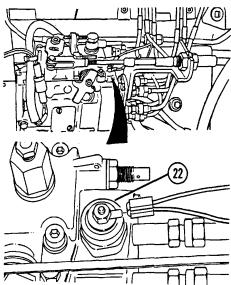
# 3-3.ENGINE ASSEMBLY - REPLACE (Cont'd)

i. Electrical lead no. 17 from oil pressure sender (20).

j. Electrical lead no. 16 from oil pressure switch (21).

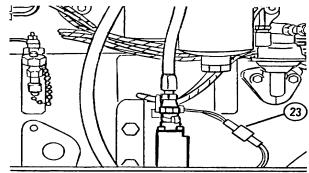
k. Electrical leads nos. 07 and R from fuel solenoid (22).



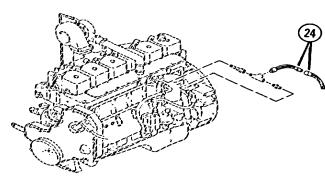


# 3-3. ENGINE ASSI!BLY - REPLACE (Cont'd)

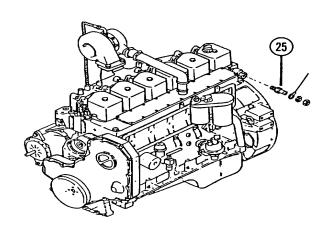
I. Pressure differential switch connector (23).



m. Pressure transducer connector (24).

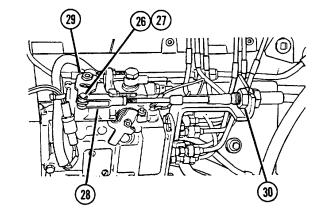


n. Electrical lead no. 14 from water temperature switch (25).



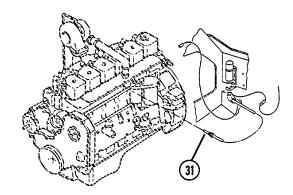
# 3-3. ENGINE ASSEMBLY - REPLACE (Cont'd)

- 5. REMOVE THROTTLE CABLE FROM THE ENGINE.
  - a. Remove cotter pin (26) and pin (27). Discard cotter pin (26).
  - b. Separate clevis (28) from the fuel injection pump control lever (29).
  - c. Loosen nut (30) and remove throttle cable from the engine.

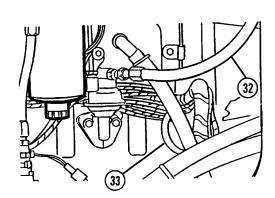


# 6. DISCONNECT TUBING AND HOSES.

a. Disconnect ether starting aid tubing (31) from intake manifold.

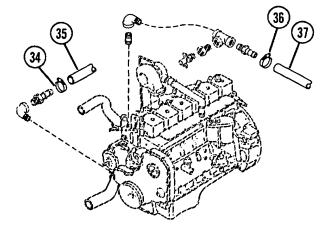


b. Tag and disconnect supply fuel hose (32) and return fuel hose (33).



# 3-3.ENGINE ASSDEBLY - REPLACE (Cont'd)

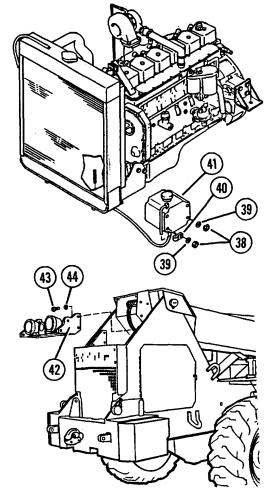
- c. Loosen clamp (34) and disconnect heater hose (35). Discard clamp (34).
- d. Loosen clamp (36) and disconnect heater hose (37). Discard clamp (36).



7. REMOVE FOUR LOCKNUTS (38), FOUR FLATWASHERS (39), ONE CLAMP (40), AND COOLANT OVERFLOW TANK (41). DISCARD LOCKNUTS (38).



- a. Attach a hoist and sling to cross member (42).
- b. Remove six capscrews (43) and lockwashers (44) to remove cross member (42).



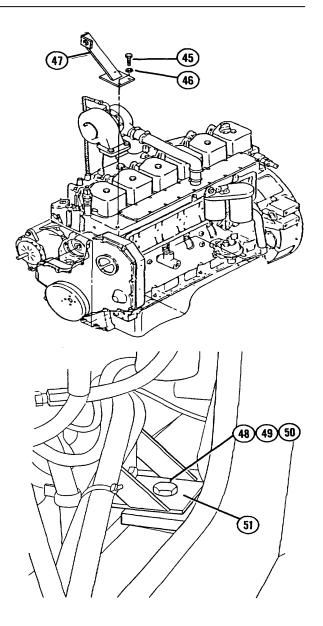
# 3-3.ENGINE ASSEIBLY - REPLACE (Cont'd)

# 9. REMOVE ENGINE MOUNTING HARDWARE.

- a. Remove three capscrews (45) and lockwashers (46) to Remove radiator support (47). Discard lockwashers (46).
- b. Remove locknut (48), rebound washer (49) and capscrew (50) from front left side and front right side engine mounts (51). Discard locknut (48).

#### **NOTE**

There is one locknut, rebound washer, and capscrew attaching each front engine mount to the vehicle frame.



#### 3-3.ENGINE ASSMBLY - REPLACE (Cont'd)

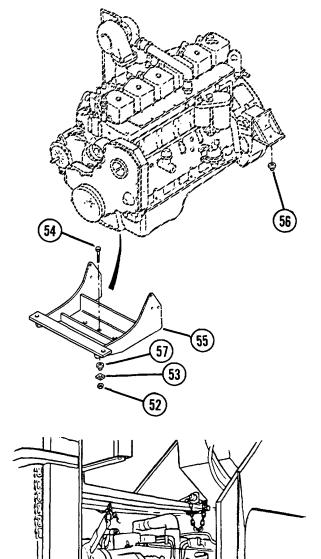
c. Remove locknut (52), rebound washer (53) and capscrew (54) from rear engine mount (55). Discard locknut (52).

# **NOTE**

Weight of the engine assembly is approximately 1, 075 lb.

#### 10. REMOVE ENGINE FROM VEHICLE.

- a. Attach lifting chains, with a lifting capacity of 2, 000 lb., to engine lifting brackets.
- b. Use a forklift truck or other suitable lifting device to remove engine. Attach lifting chains to forklift forks or other suitable lifting device.
- c. Raise engine high enough to clear rear frame support bar.
- d. Slowly remove engine through the back of the engine compartment.
- e. Place engine in a suitable engine stand.
- f. Remove and discard two front rubber mounts (56) and rear rubber mount (57).



REAR FRAME SUPPORT BAR

#### **NOTE**

There are two front rubber mounts; one under each of the two front engine mounts.

# 3-3.ENGINE ASSEMBLY - REPLACE (Cont'd)

#### **NOTE**

If a new engine is to be installed, remove engine components as directed in step 11. They will be installed on the new engine.

- 11. IF NECESSARY, REMOVE ENGINE COMPONENTS.
  - a. Remove fan, TM10-3930-660-20.
  - b. Remove alternator, TM10-3930-660-20.
  - c. Remove STE/ICE fuel pressure sender and STE/ICE fuel filter differential pressure switch, TM10-3930-660-20.
  - d. Remove starter relay, TM10-3930-660-20.
  - e. Remove oil sampling valve and fittings, TM10-3930-660-20.
  - f. Remove engine oil pressure and water temperature switches, TM10-3930-660-20.
  - g. Remove engine oil pressure and water temperature senders, TM10-3930-660-20.
  - h. Remove engine mounts, TM10-3930-660-34.
  - i. Remove flywheel housing cover, para. 3-13.
  - j. Remove coupling from flywheel, para. 3-12.
  - k. Remove ether start thermostat, TM10-3930-660-20.

# 3-3.ENGINE ASSEMBLY - REPLACE (Cont'd)

#### **INSTALLATION**

#### **NOTE**

If a new engine is being installed be sure to install components from the old engine to the new engine as directed in step 1.

- 1. IF NECESSARY, INSTALL COMPONENTS TO NEW ENGINE.
  - a. Install engine mounts, TM10-3930-660-34.
  - b. Install ether start thermostat, TM10-3930-660-20.
  - c. Install water temperature and oil pressure senders, TM10-3930-660-20.
  - d. Install engine oil pressure and water temperature switches, TM10-3930-660-20.
  - e. Install oil sampling valve and fittings, TM10-3930-660-20.
  - f. Install starter relay, TM10-3930-660-20.
  - g. Install STE/ICE fuel pressure sender and STE/ICE fuel filter differential pressure switch, TM10-3930-660-20.
- h. Install alternator, TM10-3930-660-20.
  - i. Install fan, TM10-3930-660-20.
  - j. Install coupling to flywheel, para. 3-12.
  - k. Install flywheel housing cover, para. 3-13.

# 3-3. ENGINE ASSEMBLY - REPLACE (Cont'd)

#### **NOTE**

Weight of the engine assembly is approximately 1, 075 lb.

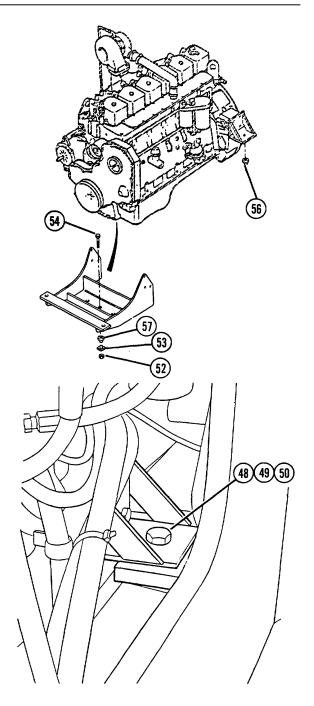
#### 2. INSTALL ENGINE.

- a. Install two new front rubber mounts (56) and rear rubber mount (57).
- b. Attach lifting chains, with a lifting capacity of 2, 000 lb., to front and rear engine lifting brackets.
- c. Attach lifting chains to forklift truck forks, or other suitable lifting device. Slowly lift and install engine through the back of the engine compartment. Lift engine high enough to clear rear frame support bar.
- d. Slowly lower engine into position over rubber mounts. Install capscrews (50 and 54), rebound washers (49 and 53) and locknuts (48 and 52).

#### **NOTE**

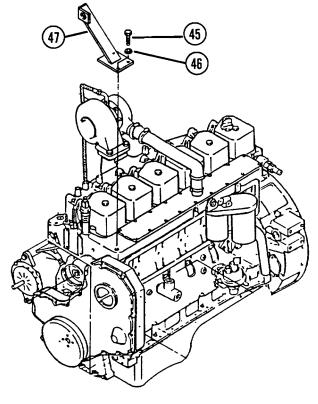
There are two locknuts, rebound washers, and capscrews attaching the front two engine mounts to the vehicle frame.

- e. Remove lifting chains. Remove hoist (forklift truck or utilized lifting device) from the vehicle area.
- f. Torque locknuts (48 and 52) to 307 lb. ft.



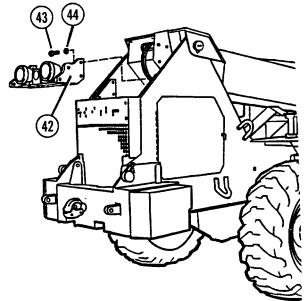
# 3-3. ENGINE ASSIDIBLY - REPLACE (Cont'd)

g. Install radiator support (47), lockwashers (46), and capscrews (45). Tighten capscrews securely.



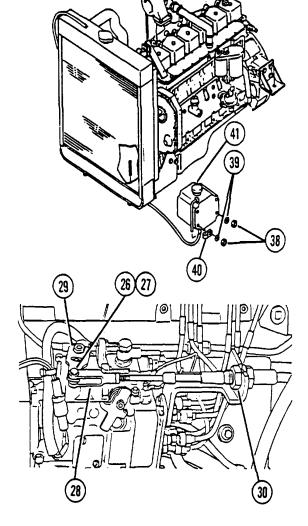
# 3. INSTALL FRAME CROSS MEMBER.

- a. Put frame cross member (42) in position using a hoist and sling.
- b. Apply Loctite 271 to threads of capscrews (43). Install new lock-washers (44) and capscrews (43). Tighten capscrews (43) to 210 lb. ft.
- c. Remove lifting device.



# 3-3.ENGINE ASSMFBLY - REPLACE (Cont'd)

4. SECURE COOLANT OVERFLOW TANK (41) AND CLUAMP (40) WITH TWO FLATWASHERS (39) AND TWO NEW LOCKNUTS (38).

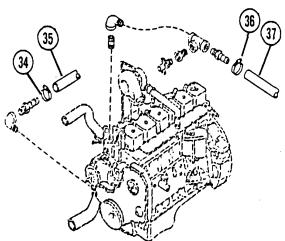


# 5. ATTACH THROTTLE CABLE TO ENGINE.

- a. Attach clevis (28) to fuel injection pump control lever (29) with pin (27) and new cotter pin (26).
- b. Place throttle cable in throttle bracket and tighten nut (30).

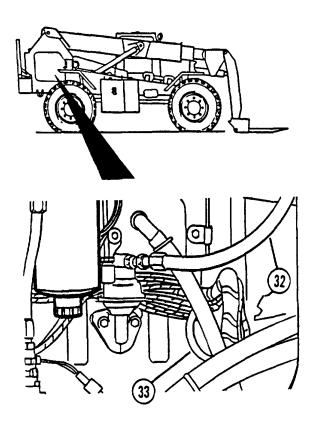


- a. Connect heater hose (35) using new clamp (34).
- b. Connect heater hose (37) using new clamp (36).

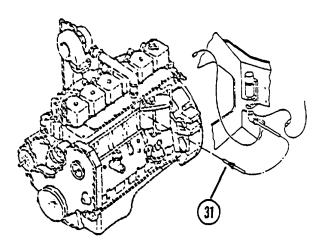


# 3-3.ENGINE ASSEMBLY - REPLACE (Cont'd)

c. Connect fuel hoses (32 and 33).



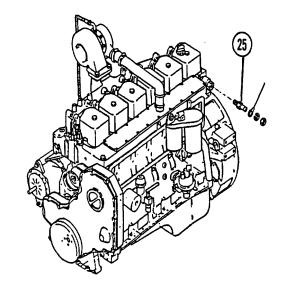
d. Connect ether starting aid tubing (31) to intake manifold.



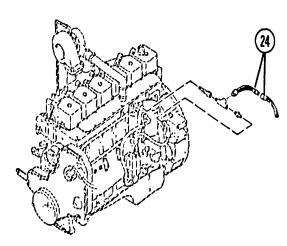
7. ROUTE ENGINE AND STE/ICE WIRING HARNESSES AS NOTED AT ENGINE REMOVAL.

# 3-3. ENGINE ASSEMBLY - REPLACE (Cont'd)

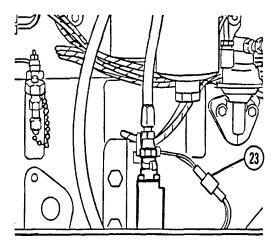
- 8. CONNECT ELECTRICAL LEADS AS INDICATED ON TAGS INSTALLED AT ENGINE REMOVAL.
  - a. Connect electrical lead no. 14 to water temperature switch (25).



b. Connect pressure transducer connector (24).

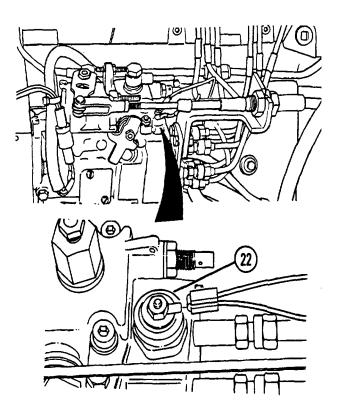


c. Connect pressure differential switch connector (23).

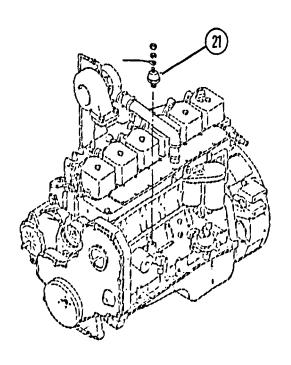


# 3-3.ENGINE ASSBMBLY - REPLACE (Cont'd)

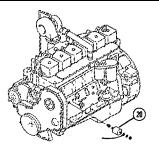
d. Connect electrical leads no. 07 and R to fuel solenoid (22).



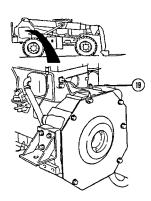
e. Connect electrical lead no. 16 to oil pressure switch (21).



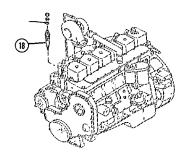
f. Connect electrical lead no. 17 to oil pressure sender (20).



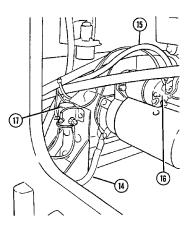
g. Connect ether thermostat connector (19).



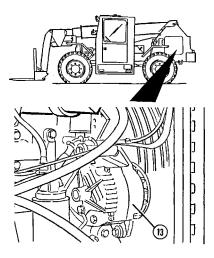
h. Connect electrical lead no. 15 to water temperature sender (18).



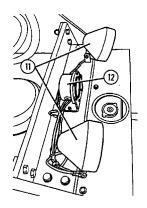
- i. Connect electrical leads to starter relay (17): lead no. 4A to rear small terminal, lead no. 38 to large front terminal, and lead no. 39 to large rear terminal.
- j. Connect electrical leads nos. 38 and S to starter solenoid (16) terminal 'S'.
- k. Connect battery positive cable (15) and wire nos. 39, T, and two wires no. 60 to starter solenoid terminal 'BAT'.
- I. Connect battery ground cable (14) and wire no. M to starter mounting capscrew.



m. Connect electrical leads nos. 60 and N to 'BAT' terminal and electrical lead no. P to '1' terminal of alternator (13).



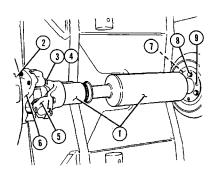
n. Connect electrical leads to back-up alarm (12) and rear floodlights (11).



- 9. INSTALL DRIVE SHAFT ASSEMBLY (1) TO ENGINE DAMPENER (7).
  - a. Position engine coupling (9) with shaft assembly (1) into engine dampener (7).
  - b. Apply Loctite 242 to three bolts (8) and secure coupling (9) to engine with capscrews (8). Tighten capscrews to 25 lb. t.



Apply Loctite 242 to four capscrews (3). Secure universal joint (5) of shaft assembly (1) to input yoke (6) of transmission (2) with four capscrews (3) and four new lockwashers (4). Torque capscrews (3) to 41 lb. ft.



- 11. TIE WRAP LINES AND ELECTRICAL WIRES AT AREAS NOTED DURING ENGINE REMOVAL, AND AS NECESSARY TO PREVENT DAMAGE TO LINES AND WIRES.
- 12. INSTALL MUFFLER, TM10-3930-660-<sup>20</sup>.
- 13. SERVICE AIR CLEANER ELEMENTS, TM10-3930-660-20.
- 14. INSTALL AIR CLEANER, TM10-3930-660-20.
- 15. INSTALL RADIATOR, TM10-3930-660-20.
- 16. SERVICE COOLING SYSTEM WITH COOLANT, TM10-3930-660-20.
- 17. SERVICE ENGINE WITH ENGINE OIL, TM10-3930-660-20.
- 18. CONNECT NEGATIVE BATTERY CABLE, TM10-3930-660-20.
- 19. ADJUST ACCELERATOR CABLE, TM10-3930-660-20.

#### 3-4. ENGINE MOUNTS - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Forklift Truck (capacity 2000 lb.)

Two Lifting Chains (capacity 2000 lb.)

# **Equipment Condition**

Radiator removed, TM10-3930-660-20. Muffler removed, TM10-3930-660-20. Engine covers and air cleaner removed, TM10-3930-660-20.

# Materials/Parts

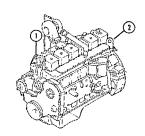
Lockwashers (5,18,20) Loctite 271 (App. B, Item 43) Rebound Washers (9,13) Rubber Mounts (21) Tags (App. B, Item 52)

#### **NOTE**

"Front" and "rear" engine references used in this paragraph are relative to the front and rear of the vehicle, with engine mounted in the vehicle. The fan side of the engine is designated the rear of the engine, and the flywheel end of engine is identified as the front of the engine.

#### **REMOVAL**

- SUPPORT ENGINE WITH LIFTING CHAINS AND FORKLIFT TRUCK.
  - a. Attach lifting chains to engine lifting brackets (1 and 2).
  - b. Attach lifting chains to forklift forks and operate forklift just enough to remove slack from lifting chains.

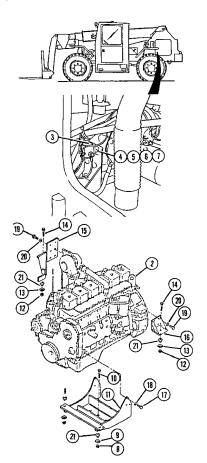


## 3-4. ENGINE MOUNTS - REPLACE (Cont'd)

- 2. TAG AND DISCONNECT ELECTRICAL LEADS FROM STARTER RELAY (3).
- 3. REMOVE STARTER RELAY (3).

Remove two nuts (4), lockwashers (5), capscrews (6), washers (7) and starter relay (3). Discard lockwashers (5).

- 4. SEPARATE ENGINE MOUNTS (11,15 and 16) FROM VEHICLE FRAME.
  - a. Remove nut (8),rebound washer (9) and capscrew (10) from rear engine mount (11).Discard rebound washer (9).
  - b. Remove nut (12),rebound washer (13) and capscrew (14) from front engine mounts (15 and 16). Discard rebound washer (13).
- 5. REMOVE ENGINE MOUNTS (11,15 and 16).
  - a. Remove three capscrews (17) and lockwashers (18) from each side of rear engine mount (11). Discard lockwashers (18).
  - b. Remove rear engine mount (11) from engine.
  - c. Remove four capscrews (19) and lockwashers (20) from left front engine mount (15) and right front engine mount (16). Discard lockwashers (20).
  - d. Remove engine mounts (15 and 16) from engine.



## 3-4. ENGINE MOUNTS - REPLACE (Cont'd)

6. REMOVE AND DISCARD THREE RUBBER MOUNTS (21) FROM VEHICLE FRAME.

## **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

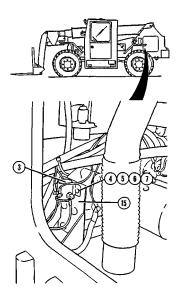
See Inspection Instructions, para. 2-11.

#### **INSTALLATION**

- 1. INSTALL NEW RUBBER MOUNTS (21) INTO VEHICLE FRAME.
- 2 INSTALL ENGINE MOUNTS (11,15 and 16) ON ENGINE.
  - a. Apply Loctite 271 to threads of capscrews (17 and 19).
  - b. Install right front engine mount (16),capscrews (19) and new lockwashers (20).Securely tighten capscrews (19).
  - c. Install left front engine mount (15),capscrews (19) and new lockwashers (20). Securely tighten capscrews (19).
  - d. Assemble rear engine mount (11) to engine. Install and securely tighten six capscrews (17) and new lockwashers (18). There are three capscrews (17) and new lockwashers (18) located on each side of the engine mount.
- 3. ATTACH ENGINE MOUNTS (11,15 AND 16) TO VEHICLE FRAME, AND REMOVE LIFTING CHAINS.
  - a. If engine was lifted for engine mounts removal, slowly lower engine onto rubber mounts (21) and align engine mounts (11,15 and 16) to new rubber mounts (21).

# 3-4. ENGINE MOUNTS REPLACE (Cont'd)

- b. Install two capscrews (14), new rebound washers (13) and nuts (12).
- c. Install capscrew (10), new rebound washer (9) and nut (8).
- d. Tighten three nuts (8 and 12) to 307 lb. ft.
- e. Remove lifting chains from engine and forklift truck. Back forklift truck away from vehicle.
- 4. INSTALL STARTER RELAY (3) AND CONNECT ELECTRICAL LEADS.
  - a. Install starter relay onto left front engine mount (15) with two capscrews
     (6), washers (7), new lockwashers (5) and nuts (4). Connect relay ground lead under lockwasher (5).
  - b. Correctly connect electrical leads to starter relay (3).
- 5. IF TRANSMISSION INPUT SHAFT WAS DISCONNECTED, CONNECT SHAFT, TM10-3930-660-20.
- 6. INSTALL MUFFLER, TM10-3930-660-20.
- 7. INSTALL RADIATOR, TM10-3930-660-20.
- 8. INSTALL ENGINE COVERS, TM10-3930-660-20.



#### 3-5. ENGINE LIFTING BRACKETS- REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

#### **Initial Setup**

#### Tools

Tool Kit , Automotive Mechanics

Materials/Parts

Loctite 242 (App. B, Item 41)

# **Equipment Condition**

Thermostat removed, TM10-3930-660-20.

#### **NOTE**

"Front" and "rear" engine references used in this paragraph are relative to the front and rear of the vehicle, with engine mounted in the vehicle. The fan side of the engine is designated the rear of the engine, and the flywheel end of engine is identified as the front of the engine.

## **REMOVAL**

- 1. REMOVE ENGINE REAR LIFTING BRACKET (1).
- 2. REMOVE ENGINE FRONT LIFTING BRACKET (3).

Remove two capscrews (2) and front lifting bracket (3).

## **CLEANING**

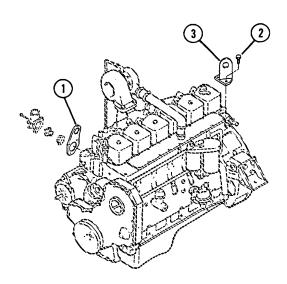
See Cleaning Instructions, para. 2-10.

## **INSPECTION**

See Inspection Instructions, para. 2-11.

## **INSTALLATION**

1. INSTALL ENGINE FRONT LIFTING BRACKET (3).



#### NOTE

Apply Loctite 242 to capscrews (2) as installed.

Install front lifting bracket (3) and two capscrews (2). Tighten capscrews (2) to 57 lb.ft.

2. ASSEMBLE ENGINE REAR LIFTING BRACKET (1) TO ENGINE, THEN INSTALL THERMOSTAT, TM10-3930-660-20.

#### 3-6. CYLINDER BLOCK - REPLACE

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics Inside Micrometer, 5 inch

Torque Wrench, 175 lb. ft.

## **Equipment Condition**

para.3-7.

Engine removed from vehicle, para. 3-3.
Valve tappets removed,para.3-17.
Camshaft and timing gears removed, para.3-18.
Crankshaft removed, para.3-8.
Flywheel housing and cover removed, para.3-13.

Cylinder head assembly removed,

## Materials/Parts

Cup Plugs (5,6 and 7) Lint-Free Rags (App. B, Item 38) Loctite #59241 (App. B, Item 45) Loctite #277 (App. B, Item 44) O-Ring (10)

Connecting rods and bearings removed, para. 3-15.
Crankshaft main bearings removed, para. 3-9.
Engine oil cooler removed, para. para.3-23.

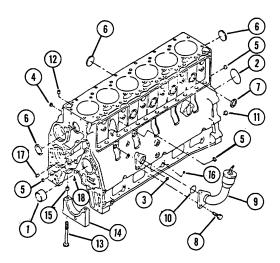
#### **REMOVAL**

- REMOVE CAMSHAFT BUSHING AND EXPANSION PLUG.
  - a. Remove camshaft bushing (1) by driving bushing inward.

## **CAUTION**

When removing camshaft expansion plug (2) in step b, below, use care not to damage camshaft bore with drift. A damaged camshaft bore can lead to premature camshaft wear.

b. Remove camshaft expansion plug (2) by driving against inside face of plug with a hammer and a long drift.



- 2. REMOVE TWO PIPE PLUGS (3) AND ONE PIPE PLUG (4).
- 3. REMOVE AND DISCARD THREE CUP PLUGS (5) FROM OIL PASSAGES.
  - a. Drill hole in center of each cup plug (5) using suitably sized drill bit.
  - Remove cup plugs (5) using a slide hammer, or other suitable tool. Discard cup plugs (5).
- 4. REMOVE AND DISCARD SIX CUP PLUGS (6) AND FOUR CUP PLUGS (7) FROM COOLANT PASSAGES.
  - a. Tap against center of each cup plug (6 or 7) using a punch and a hammer.
  - b. Grasp cup plug (6 or 7) with a plier and remove from bore. Discard cup plugs (6 and 7).
- 5. REMOVE TWO SCREWS (8),OIL FILLER PIPE (9) AND O-RING (10).DISCARD O-RING (10).
- REMOVE MISCELLANEOUS PARTS FROM CYLINDER BLOCK.
  - Remove two dowel rings (11) and two dowel rings (12).
  - b. Remove fourteen bolts (13) and seven main bearing caps (14). Remove fourteen dowel rings (15), if necessary.
  - c. Remove two expansion plugs (16).
  - d. Remove two dowel pins (17),if necessary.
  - e. Remove six piston cooling nozzles (18).

#### **CLEANING**

#### **CAUTION**

Do not clean cylinder block in an acid bath unless camshaft bushing (1) has been removed. An acid bath can severely damage camshaft bushing.

- SOAK CYLINDER BLOCK IN AN ACID BATH, IF CAMSHAFT BUSHING (1) HAS BEEN REMOVED, AND IF HEAVY DEPOSITS EXIST IN COOLANT PASSAGES.
- 2. IF CAMSHAFT BUSHING (1) HAS NOT BEEN REMOVED, AND COOLANT PASSAGES HAVE HEAVY DEPOSITS, SOAK CYLINDER BLOCK IN A SOLUTION OF HOT WATER AND LAUNDRY DETERGENT. MAINTAIN WATER TEMPERATURE OF 1900 F (880 C) AND ALLOW CYLINDER BLOCK TO SOAK FOR A PERIOD OF 30 MINUTES.
- 3. FOLLOWING CLEANING BY EITHER
  METHOD(STEP 1 OR 2),RINSE
  THOROUGHLY WITH CLEAN, FRESH WATER
  AND ALLOW SURFACE TO DRY
  COMPLETELY.
- 4 IF A SIZING HONE IS USED TO CORRECT A MINOR CYLINDER BORE TAPER OR TO REMOVE MINOR GROOVES IN CYLINDER WALLS, IMMEDIATELY CLEAN BORES USING A STRONG SOLUTION OF LAUNDRY DETERGENT AND HOT WATER. RINSE THOROUGHLY WITH CLEAR WATER.
- 5. AFTER RINSING AND DRYING CYLINDER BORES, WIPE BORES WITH WHITE, LINT-FREE CLOTH THAT IS LIGHTLY OILED. IF GRIT RESIDUE IS PRESENT ON CLOTH, CLEAN BORES AGAIN IN DETERGENT SOLUTION.

## **INSPECTION**

- CHECK FLATNESS OF CYLINDER BLOCK TOP SURFACE.
  - a. Place a straightedge along length of cylinder block top.

- b. Measure gap under straight edge in area between cylinders (five measurements, total) using a feeler gauge.
- c. Maximum allowable variation between any two of the five measurements is 0.002 inch.
- 2. INSPECT CYLINDER BORES.
  - a. Visually inspect all bores for excessive glazing. Deglaze cylinder bores, as required.

#### **NOTE**

A properly deglazed cylinder bore surface will have a crosshatched appearance with lines at angles from 15 to 25 degrees with respect to top of cylinder block. Included angles on crosshatch will be from 30 to 50 degrees.

- b. Measure diameter of each cylinder bore, from a point 1 inch below top of cylinder block to a point 5.5 inches below top of cylinder block.
- c. Minimum allowable diameter is 4.0157 inches.
- d. Maximum allowable diameter is 4.0203 inches.
- e. Maximum allowable taper is 0.003 inch.
- f. Maximum allowable out-of- roundness is 0.0015 inch.

3. INSPECT PISTON COOLING NOZZLES (18) FOR RESTRICTED OIL PASSAGES OR DAMAGE. CLEAN CLOGGED PASSAGES USING FINE, SOFT WIRE. REPLACE NOZZLES IF CONDITION IS IN DOUBT.

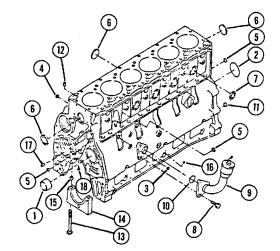
#### **INSTALLATION**

1. IF REMOVED, INSTALL SIX PISTON COOLING NOZZLES (18), USING HAMMER AND A SUITABLE PUNCH.

#### NOTE

When installed, piston cooling nozzles must be flush with or slightly below bearing saddle surface.

- 2. INSTALL MISCELLANEOUS PARTS ON CYLINDER BLOCK, AS APPLICABLE.
  - a. Install two dowel pins (17).
  - b. Install two expansion plugs (16).
  - c. Install fourteen dowel rings (15), if removed.
  - d. Install two dowel rings (11) and two dowel rings (12),if removed.
- 3. INSTALL NEW O-RING (10),OIL FILLER PIPE (9) AND TWO SCREWS (8).
- 4. INSTALL SIX NEW CUP PLUGS (6) AND FOUR NEW CUP PLUGS (7) IN COOLANT PASSAGES.



- a. Apply a bead of Loctite #277 to entire circumference of each new cup plug (6 and 7).
- b. Install new cup plugs (6 and 7) with convex side out until outer edges are flush with countersink in block.

#### **NOTE**

When installing cup plugs (5), apply Loctite #277.

- 5. INSTALL THREE NEW CUP PLUGS (5) IN OIL PASSAGES.
  - a. Apply a bead of Loctite #277 to entire circumference of each new cup plug (5).
  - b. Using a drift and a hammer, install new cup plugs (5) with convex side out and until outer edges are flush with countersink in block.
- 6. INSTALL TWO PIPE PLUGS (3) AND ONE PIPE PLUG (4).
  - a. Apply small amount of Loctite #59241 to threads of all three pipe plugs (3 and 4).
  - b. Install pipe plugs (3 and 4) and tighten to 120 lb. in.
- 7. INSTALL CAMSHAFT EXPANSION PLUG (2).
  - a. Apply a bead of Loctite #277 to entire circumference of each expansion plug (2).
  - b. Place expansion plug (2) in bore with convex side out.
  - c. Drive against convex side of expansion plug (2) using a large drift and a hammer to expand plug. Continue to drive against convex side of plug until convex side of plug is flush with face of cylinder block.

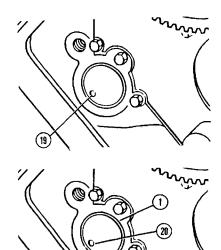
- 8. INSTALL CAMSHAFT BUSHING (1).
  - a. Mark location of oil hole (19) in camshaft bore using felt pen.
  - b. Place camshaft bushing (1) in its bore, taking care to align oil hole in bushing with oil hole (19) in camshaft bore.
  - c. Install camshaft bushing (1) until bushing is flush with face of cylinder block.
  - d. Check oil hole alignments by inserting a 0.128 inch (3.2 mm) diameter rod into bushing oil hole (20) and insuring that rod can also enter oil hole (19) in camshaft bore.

#### NOTE

The specified rod diameter represents the minimum sized oil passage required for adequate camshaft bushing lubrication. Remove and reinstall camshaft bushing (1) if oil hole alignment is unsatisfactory.



- a. Engine oil cooler, para.3-23.
- b. Crankshaft main bearings, para. 3-9.
- c. Connecting rods and bearings, para. 3-15.
- d. Flywheel housing and cover, para. 3-13.
- e. Crankshaft, para.3-8.
- f. Camshaft and timing gears, para. 3-18.
- g. Valve tappets, para.3-17.
- 10. INSTALL ENGINE IN VEHICLE, PARA.3-3.



#### This task covers:

- a Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Repair
- f. Assembly
- g. Installation

## **Initial Setup**

#### **Tools**

Tool Kit , Automotive Maintenence

Shop Equipment ,Automotive Maintenance, Common \$2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Tool Kit, Machinists: Post, Camp and Station

Lifting Chains 200 lb. capacity

Lifting Device, 200 lb. capacity

Soft Wire Wheel

Valve Spring Compressor

Valve Seat Installation and Staking Tool

#### **Equipment Condition**

TM10-3930-660-20

Engine oil drained, L010-3930-660-12. Radiator removed, TM10-3930-660-20. Engine covers removed, TM10-3930-660-20. Heater Hoses disconnected from engine, TM10-3930-660-20. Exhaust manifold removed, TM10-3930-660-20. Air cleaner removed

## Materials/Parts

Collets (11) Crocus Cloth (App. B, Item 4) Diesel Fuel Oil (App. B, Item 17) Dry Cleaning Solvent P-D-680 (App. B, Item 48) Engine Lubrication Oil, OE/HDO-15-40 (App. B, Item 26) Gasket (7) Gear Lubrication Oil, GO 80/90 (App. B, Item 32) Gloves (App. B, Item 10) Lint-Free Rags (App.B,Item 41) Lockwashers (2) Loctite \$242 4App. B, Item 41) Scotch-Bright Pads (App. B, Item 37) Seals (13) Valve Lapping Compound (App. B, Item 8)

High pressure, supply, and drain fuel lines removed, TM10-3930-660-20. Fuel injector nozzles removed, para. 4-3. Rocker arm covers removed, TM10-3930-660-20. Rocker arm assembly removed, para. 3-16. Fuel filter head removed, TM10-3930-660-20

## **REMOVAL**

1. REMOVE TOP RADIATOR MOUNT (3).

Remove three capscrews (1) and lockwashers (2), and top radiator mount (3). Discard lockwashers (2).

- 2. REMOVE 14 CAPSCREWS (4) AND SIX CAPCREWS (5) FROM CYLINDER HEAD (6). WORK FROM CENTER TO ENDS OF CYLINDER.
- 3. REMOVE CYLINDER HEAD (6).
  - Attach lifting chains and hoist (or other suitable lifting device) to engine lifting brackets. The cylinder head weighs approximately 114 pounds.

# **CAUTION**

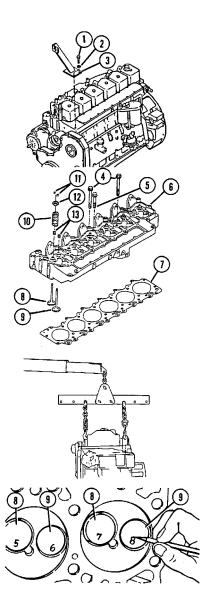
Do not lower cylinder head onto a flat surface as this could damage the valves.

- b. Slowly and carefully lift the cylinder head from the cylinder block and place it on a suitable stand or platform that will support the bottom perimeter of the cylinder head.
- 4. REMOVE AND DISCARD CYLINDER HEAD GASKET (7).

## **DISASSEMBLY**

- 1. REMOVE ENGINE LIFTING BRACKETS, PARA.3-5.
- 2. IDENTIFY INTAKE AND EXHAUST VALVES (8 and 9) IN RESPECT TO THEIR LOCATION IN THE CYLINDER HEAD.

Mark the intake valves (8) and exhaust valves (9) to identify their location in the cylinder head.



3. REMOVE INTAKE AND EXHAUST VALVES (8 AND 9) AND DISCARD COLLETS (11).

NOTE

The following valve removal procedure is applicable to all 12 valves.

- a. Compress valve spring (10) using a valve spring compressor.
- b. Remove and discard collet (11).
- Release spring pressure and remove compressor.
- d. Remove spring retainer (12) and spring (10).
- e. Remove intake and exhaust valves (8 and 9).
- f. Remove and discard valve stem seals (13).

#### **CLEANING**

#### NOTE

If cylinder head and valve components are not to be assembled right away, lightly oil and wrap the parts after inspection and before storing.

- 1. SEE CLEANING INSTRUCTIONS, PARA.
- POLISH CYLINDER HEAD GASKET SURFACES WITH SCOTCH-BRITE R PADS.
- 3. CLEAN CARBON FROM VALVES AND REMARK ACCORDING TO LOCATION IN HEAD.
  - a. Clean valve heads with a soft wire wheel.
  - b. Clean valve stems with crocus cloth.
  - c. Wash valves with fuel oil and wipe dry with clean lint free wiping rag.

d. Remark valves according to their location in the cyclinder head.

## **WARNING**

P-D-680 (Type II) is a flammable solvent that is potentially dangerous to personnel. Keep away from heat, sparks or open flame. Flashpoint of solvent is 138°F. Use only in a well ventilated area .Inhaling vapors over a period of time can cause headache and drowsiness. Use gloves to prevent irritation or inflammation of the skin. Solvent absorbed through the skin can result in internal disorders. If contact occurs, wash the affected area with water for 15 minutes For eyes, flush with water and then seek immediate medical attention.

## WARNING

Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.

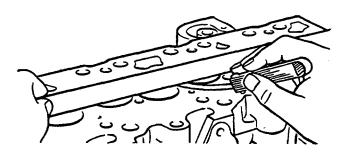
4. CLEAN VALVE SPRINGS WITH DRY CLEANING SOLVENT AND DRY THOROUGHLY WITH COMPRESSED AIR.

#### INSPECTION

- INSPECT CYLINDER HEAD ASSEMBLY.
  - a. Check for uneven surfaces and warpage of cylinder head.
  - b. Place a straightedge along length of cylinder head mating surface and check for distortion.
  - c. Measure gap under straightedge in areas indicated in chart on page 3-39.

## NOTE

If warpage, uneven surfaces, or distortion are found, cylinder head assembly must be replaced.

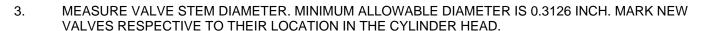


Measured Area	Variation Limit
Any 2 inch dia. area	0.004 in.
Overall end-to-end	0.003 in.
Overall side-to-side	0.003 in.

- 2 INSPECT VALVES. GRIND ALL REUSED VALVES. MARK NEW VALVES RESPECTIVE TO THEIR LOCATION IN THE CYLINDER HEAD.
  - a. Inspect valve stems for scratches or scuff marks.
  - b. Inspect valve faces for ridges, cracks, or pitting.
  - Check valve stem tip for flatness and replace valve if necessary.

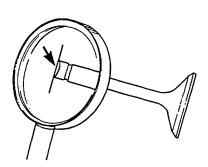
## NOTE

If a new valve is required, mark replacement location on the valve.



## **NOTE**

If a new valve is required, mark replacement location on the valve.



## **NOTE**

The cylinder head has integral valve guides. Service valve guides can be installed to meet tolerance specifications after cylinder head is machined.

#### 4. INSPECT VALVE GUIDE BORES.

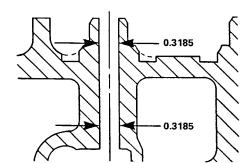
Inspect valve guide bores for scuffing or scoring. If guide bores are scuffed or scored, service valve guides must be installed. See REPAIR heading.

5. MEASURE VALVE GUIDE BORE. MAXIMUM ALLOWABLE DIAMETER IS 0.3185 INCH.

If guide bores are worn, service valve guides must be installed. See REPAIR heading.



- Inspect valve seats for scoring, scratches, or a burned condition.
- b. If a valve seat is scored, scratched, or burned it must be ground or replaced. See REPAIR heading.



## 7. INSPECT VALVE SPRINGS.

Visually inspect valve springs for nicks, deep scratches, rust deposits, notches at the end of the spring, and for wear between coils.

#### 8. CHECK SPRING FORCE USING A VALVE SPRING TESTER.

Description	Specification
Test force	65.0 - 72.2 lb.
Length under test force	1.94 in.
Free length after test	2.19 in.
Spring must not be bent	
more than	0.039 in.

## **REPAIR**

- 1. GRIND THE VALVES.
  - a. Grind valves to proper face angle.

# Valve Face Angle

Intake: 300 Exhaust: 450

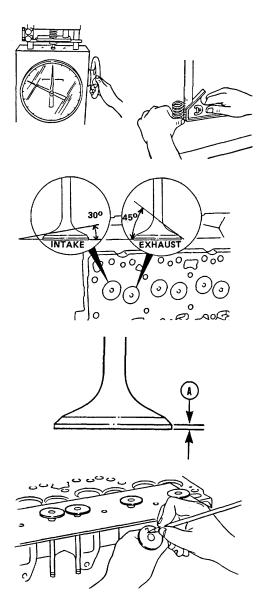
b. Measure valve rim thickness.

## Limit

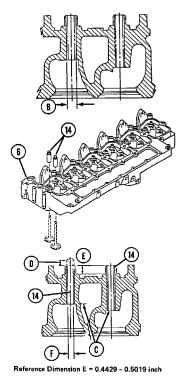
Minimum (A): 0.031 inch If rim thickness is less than 0.031 inch after grinding, replace valve.

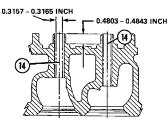
- c. Mark valves again respective to their location in the cylinder head.
- 2. MACHINE VALVE GUIDE BORES.

If valve guide bores are scratched, scored, burned, or worn, the guide bores must be machined and service valve guides installed.



- a. To install service valve guides 3906206 (thin wall intake and exhaust guides),machine cylinder head parent metal valve guide bores (B) to 0.4375 - 0.4385 inch diameter.
- b. To install service valve guides3904408 (thick wall intake) and3904409 (thick wall exhaust), machine cylinder head parent metal valve guide bores (B) to0.5507 0.5517 inch diameter.
- 3. INSTALL SERVICE VALVE GUIDES (14).
  - a. Install service valve guides 3906206 (14).
    - Lubricate valve guides with engine lubricating oil and press guides into cylinder head (6) until they are flush with bottom of guide boss at C.
    - If necessary, trim service guides (14) so they are flush with top of guide boss at D. Note the reference dimension E.
    - Finish ream service valve guides (14) to a diameter F of 0.3157 0.3165 inch.
  - b. Install service valve guides 3904408 and 3904409 (14).
    - Lubricate service guides with engine lubricating oil and press guides into cylinder head until guide is 0.4803 -0.4843 inch above cylinder head.
    - Finish ream service valve guides to a diameter of 0.3157 -0.3165 inch.





#### NOTE

Grind valve seats for a few seconds to avoid making the seats too wide.

#### 4. GRIND INTEGRAL VALVE SEATS.

Integral (parent metal) valve seats can be ground once only. Valve seats that have been previously ground are marked with one X. If regrinding of X marked seats is necessary, service seats must be installed.

- Install valves in their designated location and measure valve depth G. Valve depth is the distance from the valve face to the cylinder head surface.
- b. Record depth G for each valve.
- Lightly grind the valve seats to proper angle. Be careful not to remove too much material and cause excessive seat width.

## Seat Angle

Intake: 30° Exhaust: 45°

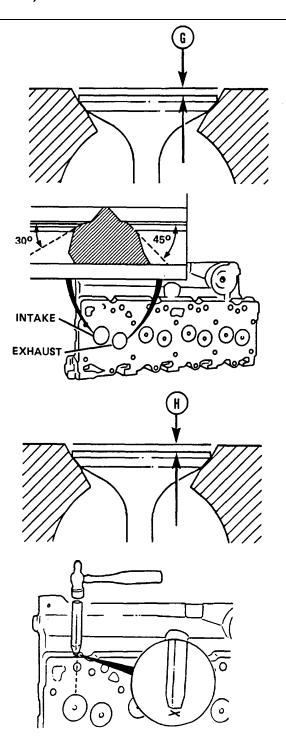
- Reinstall valves in their designated bores.
   Measure and record depth H.
- e. Calculate grinding depth (GD) from G and H measurements as follows:

$$GD = H - G$$

## **Maximum Limit**

GD - 0.010 inch

f. If GD is equal to or less than given tolerance, identify valve seat with an X.



If GD is greater than 0.010 inch, a service valve seat must be installed.

g. With valves in their designated bores, measure and record depth I.

#### **Depth Limit**

I Depth: 0.039 - 0.060 inch

- h. If depth I exceeds tolerance limits, replace the valve and check depth I again.
- i. Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.
- Remove valves and clean grinding compound from valves and seats.
- k. Measure valve seat width.

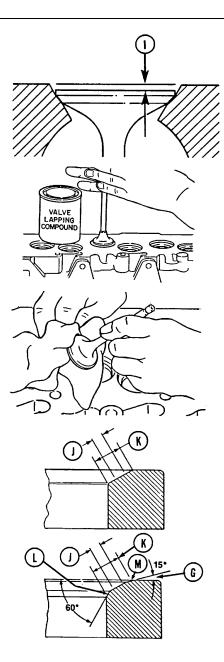
## Valve Seat Width Range Limits

Point J: 0.060 inch Point K: 0.080 inch

If valve seat is too wide after lapping, grind lower seat surface L
using a 600 seat grinder, and upper seat surface M with a 150 seat
grinder until seat width is centered and within specifications listed in
step k above.

## **NOTE**

If it was necessary to install service valve guides, STEP 3,install the service guides before installing the service seats.



5. MACHINE PARENT METAL INTAKE VALVE SEAT POCKETS AND INSTALL INTAKE VALVE SERVICE SEAT(S).

#### **NOTE**

Valve seats marked with one X at side of cylinder head have been ground once and if regrinding is necessary, a service seat must be installed.

 Machine parent metal intake valve seat pocket to the dimensions shown.

#### NOTE

#3823031 Valve Seat Installation/ Staking Tool is available from Cummins Engine Co., Inc. for installing and staking valve seats.

- b. Using a driver, push service seats (15) into machined pockets.
- Using a suitable staking tool, stake service seals into seal pockets.

## **NOTE**

Grind service seats for a few seconds only to avoid making them too wide.

 d. Grind service valve seats lightly to ensure proper seat angle.

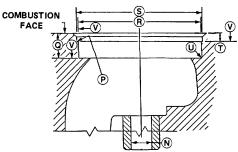
## Seat Angle

Intake: 30° Exhaust: 45°

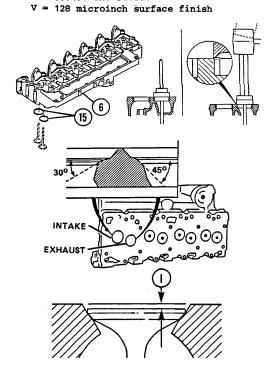
e. Install valves in their designated locations and measure depth I.

#### Limit

I Depth: 0.039 - 0.060 inch



N = 0.3157 - 0.3165 in. P = 0.015 in. radius max. Q = 0.4054 - 0.4134 in. R = 1.8499 - 1.8509 in. dia. S = 1.8848 - 1.8948 in. dia. T = 0.1454 - 0.1554 in. U = 0.0157 in. radius max.



- f. Apply a light coat of valve lapping compound to each valve and lap valve to its companion service seat.
- g. Remove valves from cylinder head and clean grinding compound from valves and service seats.
- h. Measure width of service seats.

## Valve Service Seat Width Range Limits

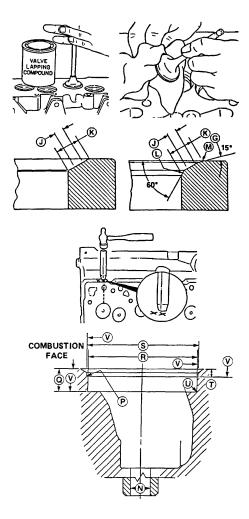
Minimum J: 0.060 inch Maximum K: 0.080 inch

- If service seat is too wide after lapping, grind lower seat surface L using a 600 seat grinder, and upper seat surface M with a 150 seat grinder until seat width is centered and within specifications listed in step h above.
- Stamp two X's on side of cylinder head in line with pocket with service seat.

# 6. MACHINE PARENT METAL EXHAUST VALVE SEAT POCKETS AND INSTALL EXHAUST

Valve seats marked with one X at side of cylinder head have been ground once and if regrinding is necessary, install service seat.

 Machine parent metal intake valve seat pocket to the dimensions shown.



N = 0.3157 - 0.3165 in.

P = 0.015 in. radius max.

Q = 0.3975 - 0.4055 in.

R = 1.7180 - 1.7190 in. dia.

S = 1.7489 - 1.7589 in. dia.

T = 0.1379 - 0.1479 in.

U = 0.0157 in. radius max.

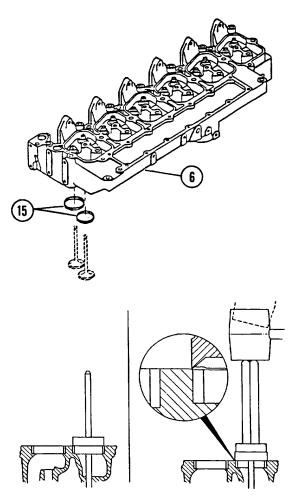
V = 128 micro inch surface finish

b. Install exhaust valve service seats in the same manner described for the intake service seats, see STEPS 5b through 5j above.

# **NOTE**

If it can not be accurately determined that service valve seats have been ground only once after initial installation, replace the seat.

- 7. GRIND VALVE SERVICE SEAT(S). GRIND SERVICE SEATS (15) FOR A FEW SECONDS ONLY TO AVOID MAKING THEM TOO WIDE.
  - Valve seats marked with two X's on the cylinder head have service seats installed. Service seats, like the parent metal seats, can only be ground once after initial installation.
  - b. Grind service seats in the same manner, and to the same tolerances, as used for grinding the integral seat in STEP 4 above.



#### **ASSEMBLY**

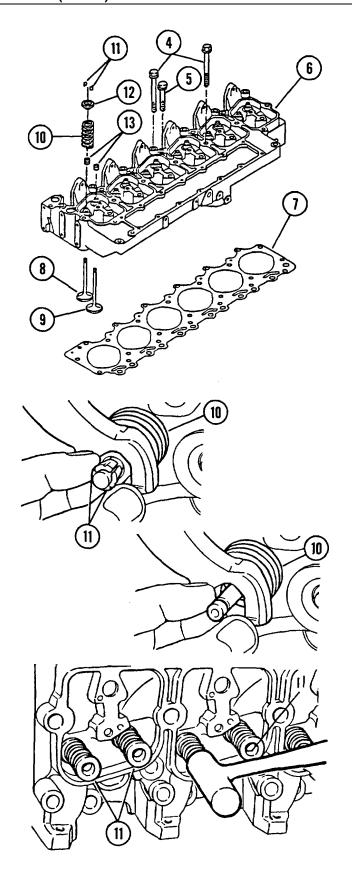
# **WARNING**

If the collet (11) is not correctly installed on the valve stem, it will unseat and be thrown with force when the spring compressor is released. The thrown collet could cause serious personal injury.

## **NOTE**

The intake and exhaust valve stem seals (13) are the same.

- 1. INSTALL VALVES.
  - a. Install new valve stem seals (13).
  - b. Put clean gear lubricating oil GO 80/90 on the valve stems and install intake valve (8) and exhaust valve (9) in their designated locations.
  - c. Install springs (10) and spring retainers (12) over valve stems (8 and 9).
  - d. Compress valve springs (10) using a valve spring compressor and install new collets (11).
  - e. Slowly release valve spring compressor and remove it from the valve.
  - f. Tap valve stems lightly to seat collets (11).
  - g. Repeat STEPS a through e for the remainder of the valves.
- 2. INSTALL ENGINE LIFTING BRACKETS, PARA. 3-5.



(Cont'd)

#### **INSTALLATION**

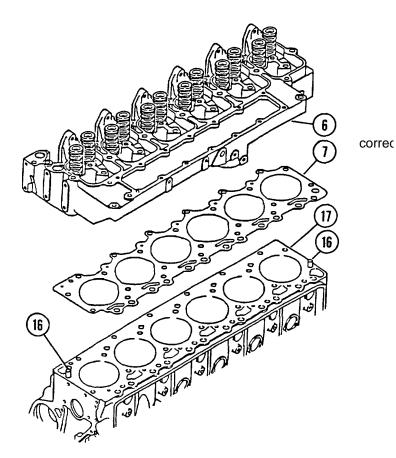
## **CAUTION**

The bottom surface of the cylinder head and top of cylinder block must be clean of all residue and dry. Dirty surfaces could cause leaks or incorrect seat between the cylinder head and block.

1. INSTALL NEW CYLINDER HEAD GASKET (7).

Install new cylinder head gasket (7) over the

- 2. PLACE CYLINDER HEAD (6) ON BLOCK (17).
  - Attach lifting chains and hoist (or other suitable lifting device) to engine lifting brackets. The cylinder head weighs approximately 114 pounds.
  - b. Carefully place cylinder head (6) over the block dowels (16) and onto block (17).
  - c. Remove lifting chains and hoist.
- 3. INSTALL ROCKER ARM ASSEMBLY, PARA. 3-16.
  DO NOT TIGHTEN MOUNTING CAPSCREWS AT
  THIS TIME.
- 4. INSTALL CYLINDER HEAD MOUNTING
  CAPSCREWS (4 AND 5). TIGHTEN TO FINAL
  TORQUE IN THE SEQUENCE SHOWN, IN
  THREE STEPS.
  - Put engine lubricating oil under the heads and on the threads of the cylinder head mounting capscrews (4 and 5).
  - b. Install capscrews (4 and 5) finger tight.



**Torque Value** 

29 lb. ft.

## 3-7. CYLINDER HEAD ASSEMBLY - REPLACE/REPAIR

 Tighten cylinder head capscrews (4 and 5) and the rocker lever pedestal M12 capscrews in the sequence shown to the final torque value in three steps.

1.....

2...... 62 lb. ft.

(Cont'd)

Step

d. Tighten rocker lever pedestal M8 capscrews to 18 lb. ft.

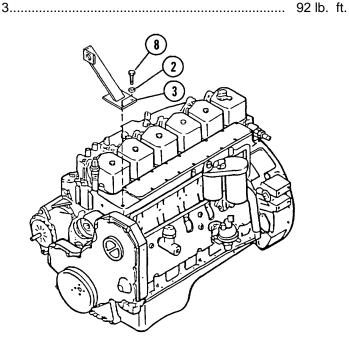
5. ADJUST VALVES, TM10-3930-660-20.

6. INSTALL ROCKER ARM COVERS, TM10-3930-660-20.

7. INSTALL TOP RADIATOR MOUNT (3).

Apply Loctite #242 to threads of capscrews(I). Install top radiator mount (3), and three new lockwashers (2) and capscrews (1).

- 8. CONNECT HEATER HOSES TO ENGINE, TM10-3930-660-20.
- 9. INSTALL FUEL FILTER, TM10-3930-660-20.
- 10.INSTALL EXHAUST MANIFOLD, TM10-3930-660-
- 11.INSTALL FUEL INJECTOR NOZZLES, PARA. 4-3.
- 12.INSTALL HIGH PRESSURE, SUPPLY, AND DRAIN FUEL LINES, TM10-3930-660-20.
- 13.INSTALL AIR CLEANER, TM10-3930-660-20.
- 14.INSTALL RADIATOR, TM10-3930-660-20.
- 15. INSTALL ENGINE COVERS, TM10-3930-660-20.
- 16. SERVICE ENGINE WITH LUBRICATING OIL, TM10-3930-660-20.



(Cont'd)

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# **INITIAL SETUP:**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common \$2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Nylon Straps (Capacity 200 lb.)

Lifting Device (Capacity 200 lb.)

**Dial Indicator** 

Inside Micrometer, 3 inch

Inside Micrometer, 4 inch

# **Equipment Condition**

Engine removed, para. 3-3

Flywheel housing and cover removed, para. 3-13.

Front housing cover only removed, para. 3-19.

Engine oil pan removed, para. 3-20

#### Materials/Parts

Capscrews (8)
Connecting Rod Bearings (10, 11)
Gasket (6)

Gloves (App. B, Item 10)

Lubriplate No. 105 (App. B, Item 16)

Main Bearings (15, 16)

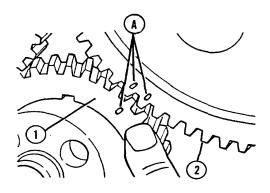
Roll Pin

Thrust Bearing (17)

## **REMOVAL**

#### 1. ALIGN AND MARK TIMING GEARS.

Turn crankshaft until timing mark on crankshaft gear (1) is aligned with timing mark on the camshaft gear (2).

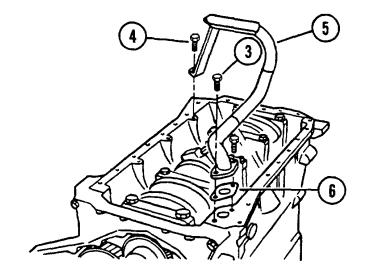


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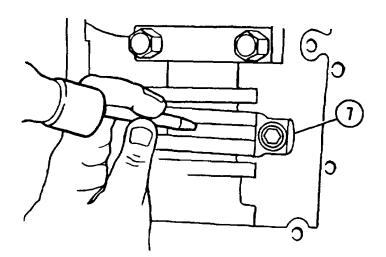
# WARNING

Be sure engine is securely attached to engine stand. If engine falls from the stand, serious bodily injury could occur and the block and crankshaft could be damaged.

- 2. CHECK THAT ENGINE IS SECURELY ATTACHED TO THE ENGINE STAND, THEN TURN ENGINE STAND SO THAT CRANKSHAFT IS UP.
- 3. REMOVE OIL SUCTION TUBE (5).
  - a. Remove two capscrews (3) and capscrew (4).
  - b. Remove oil suction tube (5) and gasket (6). Discard gasket (6).



- 4. REMOVE PISTON CONNECTING ROD CAPS (7) AND BEARINGS (10 AND 11).
  - a. Turn crankshaft until two pistons are bottom center.
  - b. Mark cylinder number onto each connecting rod cap (7).



# **CAUTION**

Be careful not to scratch or damage crankshaft when removing connecting rod caps and upper half of bearings. Any damage to the crankshaft could result in premature engine failure.

- c. Remove two capscrews (8) and connecting rod caps (7) from connecting rods (9).
- d. Push pistons and connecting rods away from crankshaft. Discard capscrews (8).

#### **NOTE**

Do not reuse connecting rod capscrews (8).

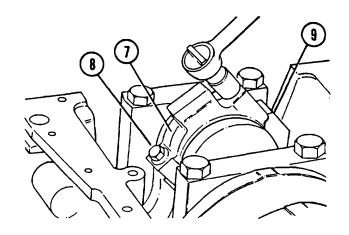
e. Remove upper bearing half (10) from connecting rods (9) and lower bearing half (11) from connecting rod caps (7). Keep connecting rod caps and bearing halves together as a set.

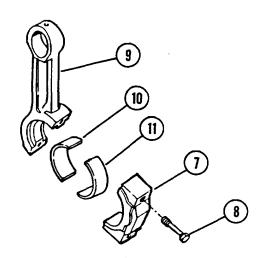
## **NOTE**

The four digit number stamped on the connecting rod and connecting rod cap are the same. Connecting rod and cap are machined as a set and must be kept that way.

5. REPEAT STEPS 4A THROUGH 4E FOR REMAINING CONNECTING ROD CAPS AND BEARINGS.

# (Cont'd)





## (Cont'd)

- 6. REMOVE MAIN BEARING CAPS (13) AND LOWER HALF OF MAIN BEARINGS (15).
  - a. Remove fourteen capscrews (12), then remove seven main bearing caps (13) from crankshaft (14).
  - b. Remove and discard lower half of main bearings (15) from bearing caps (13).
  - c. If necessary, remove fourteen ring dowels (16).

## **CAUTION**

Use only nylon straps, or equivalent, to remove crankshaft from cylinder block. Be sure that nothing hard contacts the machined surfaces of the crankshaft. A scratched or damaged crankshaft could cause premature engine failure.

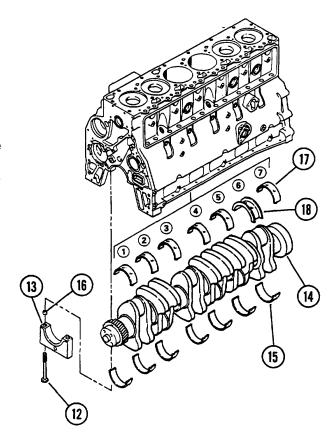
- 7. REMOVE CRANKSHAFT (14).
  - Attach nylon or equivalent straps to the crankshaft (14). The crankshaft assembly weighs approximately 123 lb.

## **CAUTION**

Be careful not to damage or scratch the crankshaft (14) during removal.

- Attach lifting straps to a suitable hoist. Slowly and carefully lift crankshaft (14) from the cylinder block.
- c. Place crankshaft (14) in a clean, dry work area.
- 8. REMOVE UPPER HALF OF MAIN BEARINGS (17) AND THRUST BEARING (18).
  - Remove and discard upper half of main bearings

     (17) from main bearing positions 1 through 5 and 7.

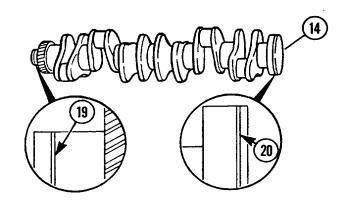


(Cont'd)

b. Remove and discard thrust bearing (18) from number 6 main bearing location in the block.

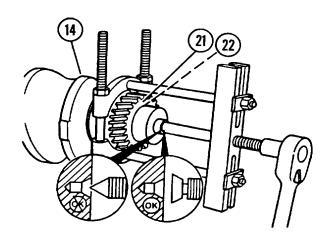
#### **DISASSEMBLY**

- REMOVE WEAR SLEEVES (19 AND 20) IF INSTALLED OR NECESSARY.
  - a. Remove and discard front wear sleeve (19) and rear wear sleeve (20) from crankshaft (14).



2. REMOVE CRANKSHAFT GEAR (21).

Use a suitable gear puller to remove crankshaft gear (21) and roll pin (22), if necessary, from crankshaft (14).



## **CLEANING**

1. SEE CLEANING INSTRUCTIONS, PARA. 2-10.

# **CAUTION**

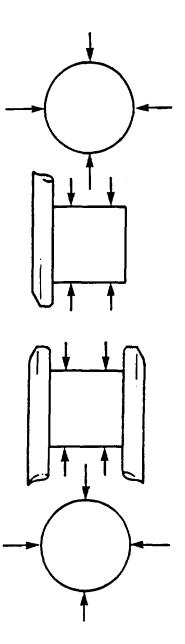
If crankshaft is not to be reinstalled within one hour after it is cleaned, apply lubricating oil on the bearing journals. Failure to comply with this recommendation will result in bearing journal corrosion.

(Cont'd)

2. APPLY LUBRICATING OIL TO ALL CRANKSHAFT BEARING JOURNALS IF CRANKSHAFT IS NOT GOING TO BE INSTALLED WITHIN ONE HOUR AFTER CLEANING.

#### **INSPECTION**

- 1. SEE INSPECTION INSTRUCTIONS, PARA. 2-11.
- 2. VISUALLY INSPECT CRANKSHAFT.
  - Inspect for large, deep cracks or broken material throughout the crankshaft, especially in the fillet and journal areas.
  - b. Inspect for a high concentration of depressions or pitting.
  - c. Inspect for burning or scoring in the journal areas.
  - d. If any of the conditions mentioned in STEPS a through c exist, replace the crankshaft.
- 3. MEASURE CRANKSHAFT BEARING JOURNALS.
  - a. Measure crankshaft main bearing journals. If any main bearing journal measures less than 3.2662 inches, replace the crankshaft or use oversize bearings. If any main bearing journal is out of round by more than 0.0020 inch, replace crankshaft or machine crankshaft and use oversize bearings.
  - Measure crankshaft connecting rod journals. If any connecting rod journal measures less than 2.7150 inches, replace the crankshaft or use oversize bearing. If any connecting rod journal is out of round by more than 0.0020 inch, replace crankshaft or machine crankshaft and use oversize bearings.

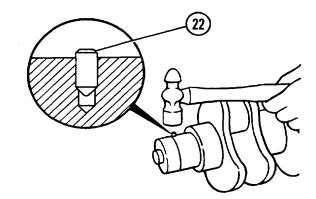


# (Cont'd)

- 4. INSPECT MAIN BEARING BORES FOR DAMAGE OR ABNORMAL WEAR, PARA. 3-9.
- 5. MEASURE DIAMETER OF MAIN BEARING BORES, PARA. 3-9.
- 6. INSPECT AND MEASURE CONNECTING ROD BEARINGS, PARA. 3-15.

#### **ASSEMBLY**

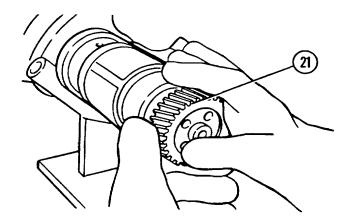
- 1. INSTALL ROLL PIN (22) AND CRANKSHAFT GEAR (21).
  - a. If a new crankshaft is being installed, a new roll pin (21) must be installed.



# **CAUTION**

Do not heat crankshaft gear (21) longer than 45 minutes. The gear will become permanently distorted if it is heated for longer than 45 minutes.

- b. Heat crankshaft gear (21) in an oven for 45 minutes at 2500F.
- Wearing insulated gloves, install crankshaft gear
   (21), with timing mark facing you, onto crankshaft until it is against the shaft shoulder.

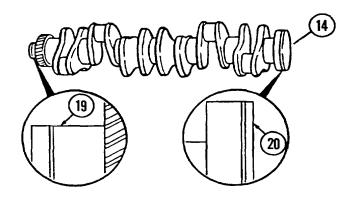


(Cont'd)

#### NOTE

Wear sleeves are used only if seal surfaces were damaged and the surface was machined to allow for sleeve installation.

- 2. INSTALL WEAR SLEEVES (19 AND 20).
  - a. Install new front wear sleeve (19) over end of crankshaft (14).
  - b. Install new rear wear sleeve (20) over end of crankshaft (14).



#### **INSTALLATION**

1. CLEAN MAIN BEARING SURFACES IN CYLINDER BLOCK, PARA. 3-9.

#### NOTE

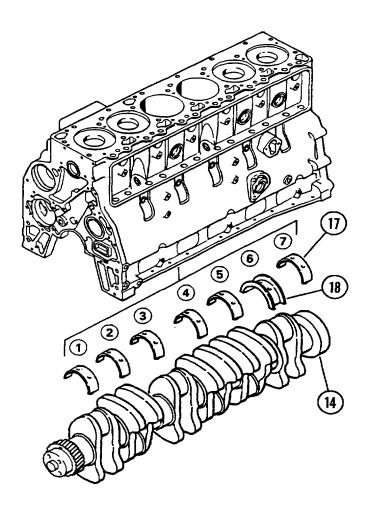
If the crankshaft journals have been ground, appropriate oversize bearings will need to be installed.

2. CHECK MAIN BEARING AND THRUST BEARING CLEARANCE.

# NOTE

Install new main bearings dry at this time. Be sure cylinder block bearing bores, backsides of bearings, and inner surface of bearing caps are clean and dry.

- Align tab of new upper bearing half (17) with groove in crankshaft bearing bore (cylinder block), and press bearing half into place.
   Perform this procedure for main bearing positions 1 through 5 and 7.
- b. Install thrust bearing (18) in crankshaft bearing bore no. 6 with tab in bearing bore groove.

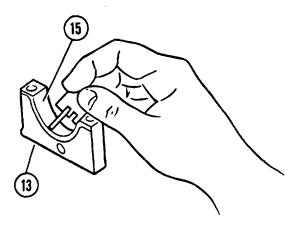


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# **CAUTION**

Use only nylon straps, or equivalent, to install crankshaft into cylinder block. Be sure that nothing metallic comes in contact with the machined surfaces of the crankshaft. A scratched or damaged crankshaft could cause premature engine failure.

- c. Attach nylon or equivalent straps to the crankshaft.
- d. Attach lifting straps to a suitable hoist. Slowly and carefully move crankshaft from the engine stand to the cylinder block.
- e. Slowly lower crankshaft into cylinder block. Be careful not to scratch the crankshaft journals.
- f. Check that the crankshaft gear-to-camshaft gear timing marks are aligned. Allow crankshaft to firmly rest against the upper main bearing halves.
- g. Place new lower bearing halves (15) in bearing caps (13) with bearing tab in groove of cap.
- h. Place a piece of plastigage on the surface of each lower main bearing half (15).



i. Apply clean lubricating oil to threads of capscrews (12), then install seven bearing caps (13) and 14 capscrews (12).

# NOTE

The number on the bearing cap must correspond to the number in the cylinder block and it must be facing towards the oil cooler side of the engine.

j. The main bearing capscrews (12) must be tightened evenly in a series of three steps, and in the sequence shown in this illustration. The torque values for each step are shown in this chart.

Step Torque Value

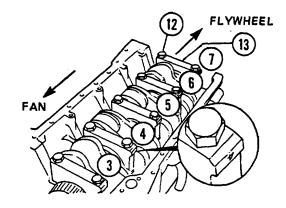
1 44 lb. ft.

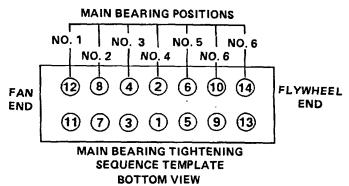
2 88 lb. ft.

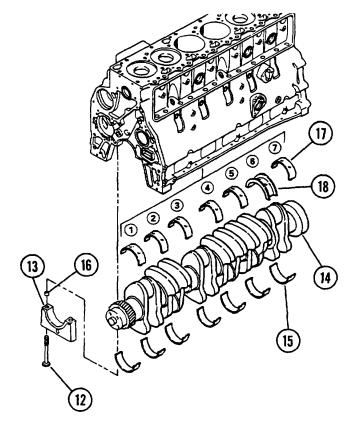
3 129 lb. ft.

- k. Remove all capscrews (12) and bearing caps (13).
- I. Remove and measure plastigage. Main bearing clearance must not exceed 0.00474 inch. If bearing clearance exceeds clearance measurement, use appropriate oversize bearings.
- m. Remove lower bearing halves (15) from bearing caps (13).

# (Cont'd)







(Cont'd)

- Lift crankshaft (14) from cylinder block far enough to remove upper bearing halves (17) and thrust bearing (18). Be careful that connecting rods do not scratch crankshaft.
- 3. INSTALL MAIN BEARINGS (15 AND 17).

# **CAUTION**

Be sure cylinder block bearing bores, backsides of bearings, and inner surface of bearing caps are clean and dry. Oil on these areas could cause less heat transfer between the bearings and the block which, in turn, could cause overheated bearings.

- a. If removal was necessary, install fourteen ring dowels (16).
- b. Place new lower bearing halves (15) in bearing caps (13) with tab inserted in cap groove.
- c. At main bearing positions 1 through 5 and 7, align tab of upper bearing half (17) with groove in bearing bore (cylinder block), and press bearing half into place.
- d. Align tab of thrust bearing (18) with groove in cylinder block at main bearing position 6, and press thrust bearing into place.
- e. Apply Lubriplate 105 to the inside surfaces of the upper and lower bearing halves and thrust bearing.

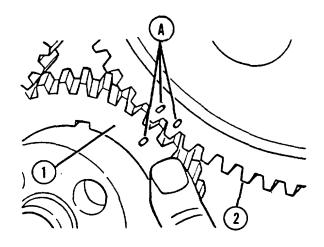
- f. Slowly lower crankshaft into cylinder block. Be careful not to scratch the crankshaft journals.
- g. Check that the crankshaft gear (1)-to-camshaft gear (2) timing marks are aligned at point "A", then allow crankshaft to firmly rest against the upper main bearing halves.
- h. Install seven bearing caps (13) and 14 capscrews (12). The number on the bearing caps must correspond to the numbers in the cylinder block and they must be towards the oil cooler side of the engine.
  - The main bearing capscrews (13) must be tightened evenly in a series of three steps, and in the sequence shown in this illustration. The torque value for each step is shown in this chart.

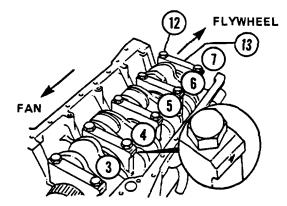
Step

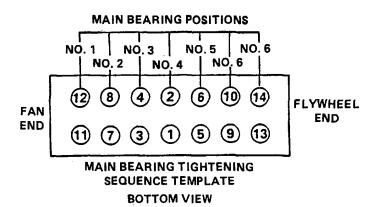
**Torque Value** 

- 1 44 lb. ft.
- 2 88 lb. ft.
- 3 129 lb. ft.

# (Cont'd)





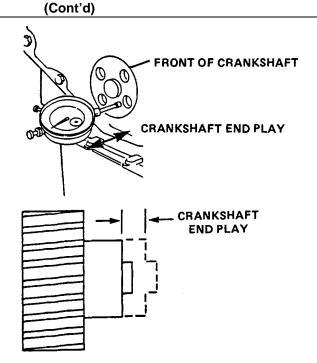


#### 4. CHECK CRANKSHAFT END PLAY.

#### **NOTE**

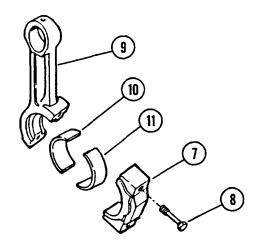
End play is controlled by the dimensions of the thrust bearing and crankshaft journal at the number 6 main bearing position.

- Measure crankshaft end play using a dial indicator as shown in this illustration.
- b. Push crankshaft forward, then toward rear of engine. With a new thrust bearing, end play limits must not exceed 0.005 0.010 inch.
- c. If end play measurement is greater than 0.010 inch, install a larger size thrust bearing.



# 5. DETERMINE CONNECTING ROD BEARING CLEARANCE. USE NEW BEARINGS.

- Turn crankshaft until two connecting rod bearing journals are bottom center.
- Be sure crankshaft journals, bearing area on connecting rods, inner surface of connecting rod caps, and connecting rod bearings are dry and clean.
- c. Put new upper bearing half (10) on connecting rod (9) and pull piston and connecting rod assembly against crankshaft journal. Bearing tabs must be in the tab grooves of the connecting rod (9).



- d. Put new lower bearing half (11) in connecting rod cap (7). Bearing tabs must be in the tab grooves of the rod cap.
- e. Put plastigage on the surface of the lower half of connecting rod bearing.

(Cont'd)

# **CAUTION**

The four digit number stamped on the connecting rod and the rod cap must match and be facing the oil cooler side of the engine. Connecting rod and cap are machined as a set and must be kept that way. Failure to install matched sets could result in premature engine damage.

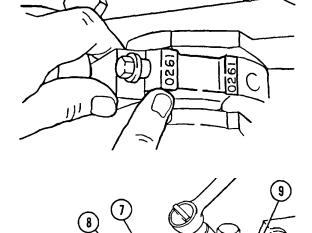
#### NOTE

Do not reuse connecting rod capscrews.

- f. Apply lubricating oil to threads of new connecting rod capscrews, then install connecting rod cap (7) on connecting rod (9) with new capscrews (8).
- g. The connecting rod capscrews (8) must be tightened evenly in a series of three steps. The torque value for each step is shown in this chart.

Step Torque Value

- 1 26 lb. ft.
- 2 52 lb. ft.
- 3 73 lb. ft.



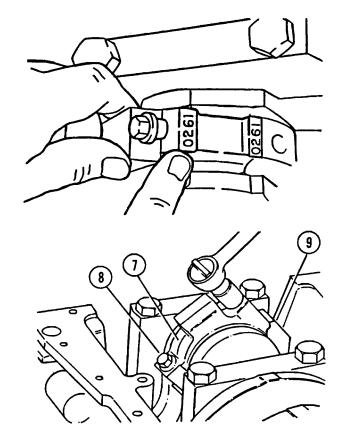
# (Cont'd)

- h. Remove capscrews (8) and connecting rod caps (7).
- Measure plastigage to determine what size connecting rod bearings to install.
- j. Repeat STEPS a through i for the other five connecting rods.
- 6. INSTALL CONNECTING ROD BEARINGS (10 AND 11) AND CAPS (7).
  - Turn crankshaft until two connecting rod bearing journals are bottom center.
  - b. Put upper bearing half (10) on connecting rod (9) with tab in the rod groove.
  - Put lower bearing half (11) in connecting rod cap (7) with tab in cap groove.
  - Apply Lubriplate 105 to inside surfaces of upper and lower bearing halves.

#### **CAUTION**

The four digit number stamped on the connecting rod and the rod cap must match and be facing the oil cooler side of the engine. Connecting rod and cap are machined as a set and must be kept that way. Failure to install matched sets could result in premature engine damage.

e. Pull piston and connecting rod assembly against crankshaft journal and install bearing cap (7) with new capscrews (8). Be sure the four digit number stamped on the bearing cap matches the number stamped on the connecting rod and that it is facing towards the oil cooler end of the engine.



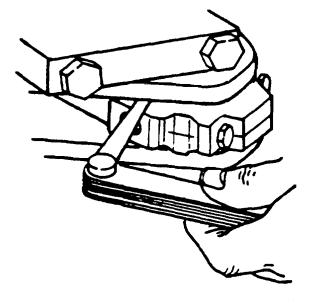
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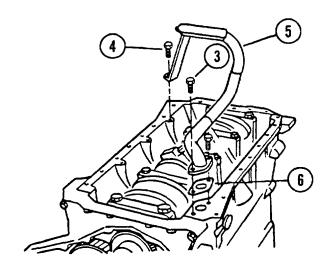
f. The connecting rod capscrews (8) must be tightened evenly in a series of three steps. The torque value for each step is shown in the following chart.

# Step

# **Torque Value**

- 1 26 lb. ft.
- 2 50 lb. ft.
- 3 73 lb. ft.
  - g. Repeat STEPS a through g for the other five connecting rods.
- 7. MEASURE CONNECTING ROD SIDE PLAY AT EACH CONNECTING ROD ASSEMBLY.
  - a. Measure connecting rod side play.
  - b. Wear tolerance is 0.012 inch maximum.
  - c. If side play exceeds wear tolerance stated in step b, replace connecting rod and connecting rod cap.
- 8. INSTALL OIL SUCTION TUBE AND GASKET.
  - a. Install gasket (6) on cylinder block.
  - b. Position oil suction tube (5) over gasket (6) and install capscrews (3 and 4).
  - c. Tighten capscrews (3 and 4) to 18 lb. ft.
- 9. INSTALL OIL PAN, PARA. 3-20.
- 10. INSTALL FRONT HOUSING COVER, PARA. 3-19.
- 11.INSTALL FLYWHEEL HOUSING AND COVER, PARA. 3-13.
- 12. INSTALL ENGINE, PARA. 3-3.





#### 3-9. CRANKSHAFT MAIN BEARINGS - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

#### **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance Common #2, Less Power

Fabricated Tool - Bearing Removal/ Installation Tool (App. C, Fig. C-7)

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

# **Equipment Condition**

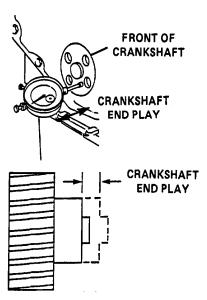
Vehicle parked on level ground. Oil pan removed, para. 3-20. Oil suction tube removed, para. 3-21.

# Materials/Parts

Dry Cleaning Solvent P-D-680 (App. B, Item 48)
Lint-Free Rags (App. B, Item 38)
Lubricating Oil (App. B, Item 26)
Lubriplate 105 (App. B, Item 16)

#### **REMOVAL**

- 1. CHECK CRAKSHAFT END PLAY.
  - End play is controlled by the dimensions of the thrust bearing and crankshaft journal at the number 6 main bearing position.
  - b. Measure crankshaft end play using a dial indicator as shown in this illustration.
  - Push crankshaft forward, then toward rear of engine. Record end play measurement. This data will be needed later during thrust bearing installation.
- REMOVE MAIN BEARINGS (3 AND 4) FROM MAIN BEARING LOCATIONS 2 THROUGH 6.



Bearing removal instructions for main bearings 1 and 7 will be covered in the INSTALLATION paragraph.

- a. If main bearing position number on bearing cap is missing or hard to read, etch the correct number on the bearing cap so that it is facing the oil cooler side of the engine.
- Remove one main bearing set at a time.
  Remove two capscrews (1) and bearing cap
  (2) from main bearings 2, 3, 4, 5, or 6 only.
  DO NOT remove bearing caps from main bearings 1 and 7 at this time.

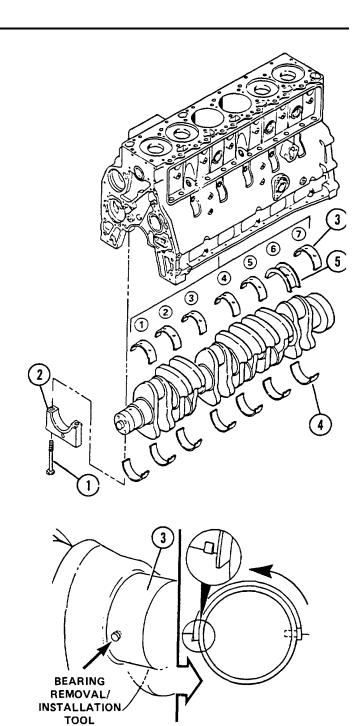
# **CAUTION**

If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.

- c. Install bearing removal/installation tool (App. C, Fig. C-7) into oil hole in crankshaft journal for main bearing being removed.
- d. Slowly turn crankshaft so the bearing removal/installation tool pushes against the end of the bearing opposite the tab, and upper bearing half (3) is out of the cylinder block.
- e. Remove bearing removal/installation tool from crankshaft oil hole.
- f. Remove lower bearing half (4) from bearing cap (2). Keep main bearings and bearing caps together as a set.

#### **NOTE**

When bearings are reused, each bearing must be installed in its original location because the bearing surfaces have a wear pattern matched to the crankshaft journals.



g. Repeat STEPS a through f for remaining main bearings 2 through 5 and thrust bearing (5) at main bearing position 6.

#### **CLEANING**

#### **CAUTION**

Never use any type of rough material or tools such as sandpaper, emery or crocus cloth, files, or glassbead cleaning equipment to clean bearings.

- 1. SEE CLEANING INSTRUCTIONS, PARA. 2-10.
- APPLY A LIGHT COAT OF OIL OVER THE BEARINGS AND THE BEARING SURFACE IN THE BEARING CAPS IF THE BEARINGS ARE NOT GOING TO BE INSTALLED WITHIN ONE HOUR AFTER CLEANING.

# **INSPECTION**

- INSPECT MAIN BEARINGS AND THRUST BEARING. REPLACE BEARING IF:
  - back of bearing shows that fretting has taken place,
  - back of bearing has a mirror-like (shiny) finish.
  - there are scratches in the bearing surface which do not disappear after cleaning,
  - bearing surface has material damage such as cracks or flaking,
  - there is a hole in the bearing surface,
  - bearing shows wear on the mating face,
  - bearing oil hole is distorted,

- there are hot spots in bearing surface, and/or
- bearing has damage to the tab.
- INSPECT THRUST BEARING FLANGES FOR DAMAGE. IF DAMAGED, REPLACE THRUST BEARING.
- 3. INSPECT MAIN BEARING BORES IN THE BLOCK FOR CRACKS, CHIPS, DISTORTION, THREAD DAMAGE, OR OTHER DAMAGE. REPLACE CYLINDER BLOCK IF THERE IS BEARING BORE DAMAGE.
- 4. INSPECT AND MEASURE CRANKSHAFT MAIN BEARING JOURNALS, PARA. 3-8.
- INSPECT MAIN BEARING CAPS FOR CRACKS, FRETTED OR CHIPPED MATING SURFACES, DISTORTION, OR DAMAGED RING DOWELS.
  - a. Replace a damaged bearing cap.
  - Replace both bearing cap ring dowels if one or both are damaged.

#### **INSTALLATION**

- 1. INSTALL MAIN BEARINGS 2 THROUGH 6 (3 AND 4) FOR MAIN BEARING CLEARANCE CHECKS.
  - a. If main bearings are coated with oil, remove oil with a clean wiping rag.

#### CAUTION

To help prevent damage to the cylinder block during main bearing bore cleaning, compressed air shall not exceed 15 psig. Use compressed air only with effective chip guarding and personal protective equipment.

 b. Clean main bearing surfaces in the cylinder block and bearing caps with cleaning solvent P-D-680. Dry surfaces thoroughly with low pressure compressed air (15 psig max.).

#### NOTE

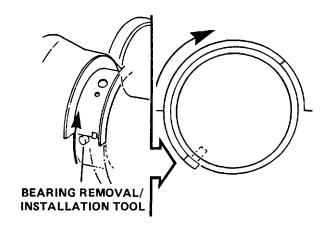
Install bearing halves dry for the following clearance checks.

- c. Refer to end play data measured earlier in REMOVAL, STEP 1. If crankshaft end play is not within 0.005 to 0.010 inch, install a new, appropriate oversize thrust bearing (5).
- d. Install a dry upper main bearing half (3) over the crankshaft journal such that the bearing tab will fit into the notch in cylinder block. If used main bearing is being installed, install upper bearing half in the same position it was removed from.
- e. Insert bearing removal/installation tool, (App. C, Fig. C-7) into bearing journal oil hole so that it will push against tab end of bearing.

# **CAUTION**

If the crankshaft is turned in the wrong direction, the bearing tab will be pushed between the crankshaft and bearing area in the block. This could cause damage to the block and the crankshaft.

- f. Slowly turn crankshaft in the correct direction until upper bearing tab is in the cylinder block notch.
- g. Remove bearing removal/installation tool from crankshaft oil hole.



#### **NOTE**

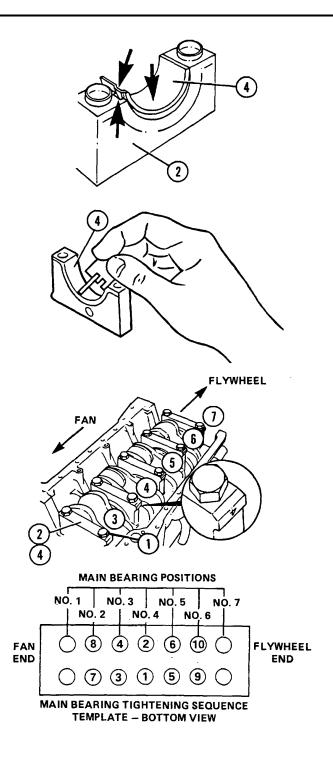
After each upper bearing half (4) is installed, install the respective lower bearing half (4) and bearing cap (2) as described in the following steps.

h. Install a dry lower main bearing half (4) in bearing cap (2). Tab on bearing must be in the notch in bearing cap. If used main bearing is being installed, install bearing in the same bearing cap it was removed from.

#### NOTE

Do not turn crankshaft after plastigage is in position. Plastigage will be distorted.

- i. Place plastigage on the surface of lower main bearing half (4).
- j. Apply a light coat of lubricating oil on threads of capscrews (1). Install bearing (4), bearing cap (2), and two capscrews (1). The bearing cap must be installed in the same position it was removed from with number on bearing cap facing towards the oil cooler side of engine.
- After each bearing and bearing cap is installed, tighten capscrews (1) to 37 lb. ft.
   Do not tighten capscrews to final torque value at this time.
- Repeat STEPS a through j for the other main bearings 2 through 5 and thrust bearing at position number 6.
- m. Tighten capscrews (1) evenly, in the sequence shown, to 44 lb. ft.
- n. Tighten capscrews (1) evenly again in the sequence shown to 88 lb. ft.

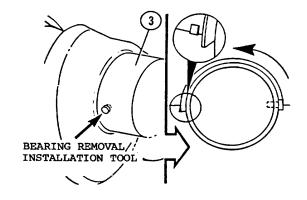


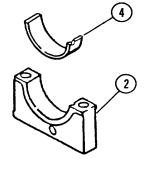
- o. Tighten capscrews (1) evenly in the sequence shown to 129 lb. ft. final torque.
- 2. CHECK BEARING CLEARANCE FOR MAIN BEARINGS 2 THROUGH 6.
  - a. Remove two capscrews (1) and bearing cap (2) from main bearings 2, 3, 4, 5, or 6. Remove one set of main bearings at a time.
  - Remove and measure plastigage. Main bearing clearance must not exceed 0.00474 inch. If bearing clearance exceeds the specified measurement, the appropriate oversize bearing set must be installed.

# **CAUTION**

If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.

- c. Install bearing removal/installation tool (App. C, Fig. C-7) into oil hole in crankshaft journal for main bearing being removed.
- d. Slowly turn crankshaft so the special pin pushes against the end of the bearing opposite the tab, and upper bearing half (3) is out of the cylinder block.
- e. Remove bearing removal/installation tool from crankshaft oil hole.
- f. Remove lower bearing half (4) from bearing cap (2). Keep main bearings and bearing caps together as a set.



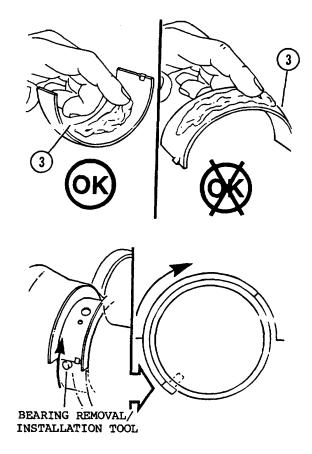


a.

#### **NOTE**

When bearings are reused, each bearing set must be installed in its original location because the bearing surfaces have worn to the crankshaft journals.

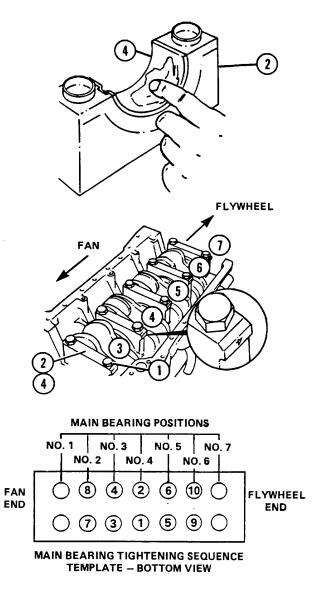
- g. Repeat STEPS a through f for remaining main bearings 2 through 5 and thrust bearing at main bearing position 6.
- 3. INSTALL MAIN BEARINGS 2 THROUGH 6 (3 AND 4).
  - a. Be sure bearing bore surfaces in the cylinder block are clean and dry.
  - b. Check that the backsides of main bearings are clean and dry.
  - c. Check that inside surfaces of bearing caps are clean and dry.
  - d. Apply Lubriplate 105 to the inside surface of upper bearing half (3). Do not lubricate the side that is against the cylinder block bearing bore.
  - e. Install one bearing set at a time. Install upper main bearing half (3) over the crankshaft journal such that the bearing tab will fit into the notch in cylinder block. If used main bearing is being installed, install main bearing half in the same position it was removed from. If a new bearing is being installed, use the correct size bearing as determined in STEP 2 above.
  - f. Insert bearing removal/installation tool (App. C, Fig. C-7) into bearing journal oil hole so that it will push against tab end of bearing.



#### **CAUTION**

If the crankshaft is turned in the wrong direction, the bearing tab will be pushed between the crankshaft and bearing area in the block. This could cause damage to the block and the crankshaft.

- g. Slowly turn crankshaft in the correct direction until upper bearing tab is in the cylinder block notch.
- h. Remove bearing removal/installation tool from crankshaft oil hole.
- Place lower bearing half (4) into bearing cap (2) that it was removed from. If a new bearing is being installed, use the correct size bearing as determined in STEP 2 above. Apply Lubriplate 105 to inside surface of bearing half.
- j. Install bearing (4), bearing cap (2) and two capscrews (1) on bearing bore with the same number as that stamped on cap, with number facing towards the oil cooler side of engine.
- k. After installing each bearing and bearing cap, tighten capscrews (1) to 37 lb. ft. Do not tighten capscrews to final torque value at this time.
- I. Repeat STEPS a through k for the other main bearings 2 through 5 and thrust bearing (5) at position number 6.
- m. Tighten capscrews (1) evenly in the sequence shown to 44 lb. ft.
- n. Tighten capscrews (1) evenly again in the sequence shown to 88 lb. ft.

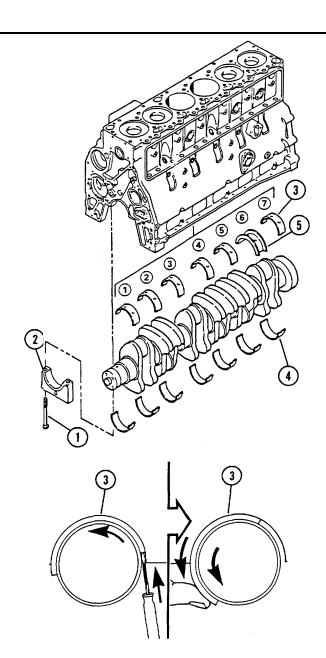


- o. Tighten capscrews (1) evenly in the sequence shown to 129 lb. ft. final torque.
- 4. REMOVE MAIN BEARINGS (3 AND 4) FROM MAIN BEARING LOCATIONS 1 AND 7.
  - a. If main bearing position number on bearing cap is missing or hard to read, etch the correct number on the bearing cap so that it is facing the oil cooler side of the engine.
  - Remove two capscrews (1) and bearing cap (2) from number 1 main bearing.
     Remove lower bearing half (4) from bearing cap (2).

#### **CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the removal of the upper bearing halves. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.

- c. Use a flat blade screwdriver to remove the upper half of main bearing number 1 because the crankshaft journal for number 1 main bearing does not have an oil hole.
  - Gently push end of upper bearing half (3) to loosen it from the cylinder block.
- d. Press finger against bearing and turn crankshaft to roll the bearing (3) from the cylinder block.



#### **CAUTION**

If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.

e. Remove number 7 main bearing, REMOVAL STEPS 2b through 2f.

#### NOTE

When bearings are reused, each bearing must be installed in its original location because the bearing surfaces have worn to the crankshaft journals.

- 5. CLEAN AND INSPECT NUMBER 1 AND NUMBER 7 MAIN BEARINGS, CLEANING STEPS 1 AND 2, INSPECTION STEPS 1, 3, 4, AND 5.
- 6. CHECK NUMBER 1 MAIN BEARING (3 AND 4) CLEARANCE.
  - a. If main bearings are coated with oil, remove oil with a clean wiping rag.

#### **CAUTION**

To help prevent damage to the cylinder block during main bearing bore cleaning, compressed air shall not exceed 15 psig. Use compressed air only with effective chip guarding and personal protective equipment.

 Clean main bearing surfaces in the cylinder block and bearing caps with cleaning solvent P-D-680. Dry surfaces thoroughly with low pressure compressed air (15 psig max.).

#### NOTE

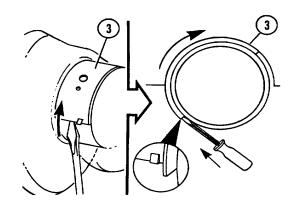
Install bearing halves dry for the following clearance checks.

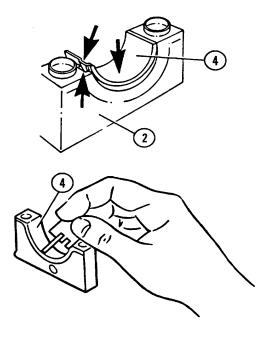
c. Install a dry upper bearing half (3) over the crankshaft journal for main bearing number 1 such that the bearing tab will fit into the notch in cylinder block. If used main bearing is being installed, install main bearing half in the same position it was removed from.

#### **CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the installation of the upper bearing halves. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.

- d. Simultaneously push the upper bearing half, with a flat blade screwdriver, and turn the crankshaft until bearing tab is in notch in cylinder block.
- e. Install a dry lower main bearing half (4) in number 1 main bearing cap (2). Tab on bearing must be in the notch in bearing cap. If used main bearing is being installed, install bearing in the same bearing cap it was removed from.
- f. Place plastigage on the surface of lower main bearing half (4).





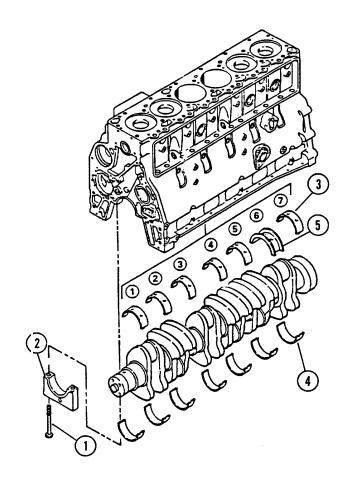
- g. Apply a light coat of lubricating oil on threads of capscrews (1).
- h. Install bearing (4), bearing cap (2) and two capscrews (1) on the number one bearing bore in the cylinder block.
- i. Alternately tighten two capscrews (1) to final torque value in these three steps:

Step	Torque Value
1	44 lb. ft.
2	88 lb. ft.
3	129 lb. ft.

- j. Check number 1 main bearing clearance, STEPS 2a and 2b.
- k. Remove number 1 main bearing, STEPS 4b, 4c, and 4d.
- 6. CHECK NUMBER 7 MAIN BEARING (3 AND 4) CLEARANCE.
  - a. Install number 7 main bearing, STEPS la through lj.
  - b. Alternately tighten capscrews (1) to final torque value in these three steps:

Step	Torque Value
1	 44 lb. ft.
2	88 lb. ft.
3	129 lb. ft.

c. Check bearing clearance, STEPS 2a through 2f.



- 7. INSTALL NUMBER 1 AND NUMBER 7 MAIN BEARINGS (3 AND 4).
  - Install number 1 main bearing (3 and 4), STEPS 3a through 3e.

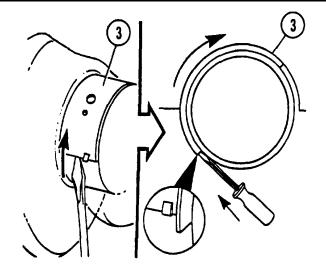
# **CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the installation of the upper bearing half. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.

- b. To insert upper half of number 1 main bearing into bearing bore, simultaneously push the upper bearing half with a flat blade screwdriver and turn the crankshaft until bearing tab is in notch in cylinder block.
- c. Continue with number 1 bearing installation, STEPS 3i, 3j, and 3m through 30.
- 8. CHECK CRANKSHAFT ROTATION.

Crankshaft must turn freely. If it does not turn with relative ease, check bearing installations and size of bearings.

- 9. CHECK CRANKSHAFT END PLAY, PARA. 3-8, STEP 4.
- 10. INSTALL OIL SUCTION TUBE, PARA. 3-21.
- 11. INSTALL OIL PAN, PARA. 3-20.



#### 3-10.1 CRANKSHAFT FRONT SEAL - REPLACE

This task covers:

a.Removal

b.Installation

# Initial Setup

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power

Slide Hammer Dent Puller

**Equipment Condition** 

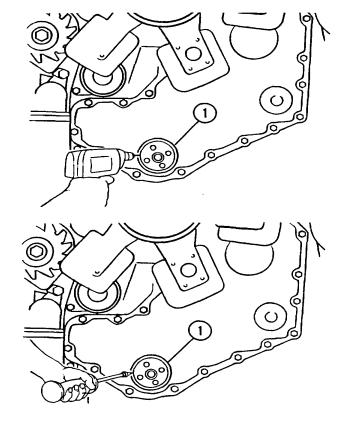
Crankshaft vibration damper removed, para. 3-11.

Materials/Parts

Front Oil Seal (1)
Lint-Free Rags (App. B, Item 38)
Loctite 1227 (App. B, Item 44)
110 Sheet Metal Screw

# **REMOVAL**

- 1. DRILL TWO 1/8 INCH HOLES 180 DEGREES APART IN SEAL CARRIER.
- REMOVE FRONT SEAL WITH SLIDE HAMMER DENT PULLER.
  - Insert a 110 sheet metal screw into end of slide hammer dent puller.
  - b. Alternately put slide hammer dent puller into the two 1/8 inch drilled holes and pull until oil seal (1) is removed.
  - c. Discard front oil seal (1).



# 3-10.1 CRANKSHAFT FRONT SEAL - REPLACE (Cont'd)

#### **INSTALLATION**

#### **CAUTION**

The seal lip and sealing surface on crankshaft must be clean to help prevent an oil leak around the seal.

 CLEAN SEAL LIP AND SEALING SURFACE ON CRANKSHAFT WITH CLEAN WIPING RAGS.

#### **CAUTION**

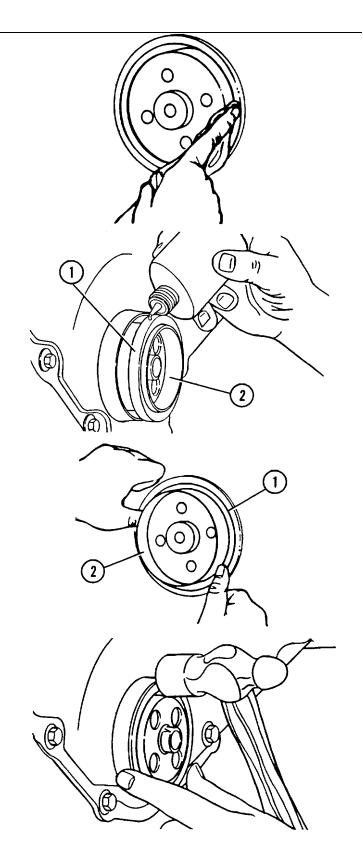
The seal and seal pilot used in STEP 2 are packaged as a single item. Do not separate these two components before seal installation. Failure to use the pilot could result in a damaged seal.

- INSTALL OIL SEAL (1) AND SEAL PILOT (2) ONTO CRANKSHAFT.
- 3. APPLY A BEAD OF LOCTITE #277 AROUND OUTSIDE SURFACE OF OIL SEAL (1).
- 4. PUSH ON SEAL (1) UNTIL OIL SEAL (1) IS INSIDE GEAR COVER, THEN REMOVE SEAL PILOT (2).

#### **CAUTION**

Drive the alignment/installation tool at the 12, 3, 6, and 9 o'clock positions only. Driving the tool at other positions could damage the seal carrier.

- 5. INSTALL OIL SEAL (1) TO CORRECT DEPTH USING ALIGNMENT/INSTALLATION TOOL SUPPLIED WITH THE OIL SEAL (1).
  - Position the alignment/installation tool over the crankshaft and against the seal carrier with the flange of the tool away from the seal.
  - b. Use a hammer to tap seal into front cover until flange of tool is against front cover.
- 6. INSTALL CRANKSHAFT VIBRATION DAMPER, PARA. 3-11.



#### 3-10.2 CRANKSHAFT REAR SEAL - REPLACE

This task covers:

a.Removal

b.Installation

# Initial Setup

# **Tools**

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power

Slide Hammer Dent Puller

# **Equipment Condition**

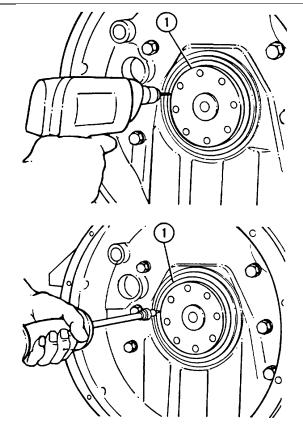
Flywheel removed, para. 3-12

### Materials/Parts

Lint-Free Rags (App. B, Item 38) Rear Oil Seal (1) #10 Sheet Metal Screw

#### **REMOVAL**

- 1. DRILL TWO 1/8 INCH HOLES 180 DEGREES APART IN SEAL CARRIER.
- 2. REMOVE REAR CRANKSHAFT SEAL WITH SLIDE HAMMER AND DENT PULLER.
  - a. Insert a #10 sheet metal screw into end of slide hammer dent puller.
  - b. Alternately put slide hammer dent puller into the two 1/8 inch drilled holes and pull until oil seal (1) is removed.
  - c. Discard rear oil seal (1).



### 3-10.2 CRANKSHAFT REAR SEAL - REPLACE (Cont'd)

#### **INSTALLATION**

# **CAUTION**

The seal lip and sealing surface on crankshaft must be clean to help prevent an oil leak around the seal.

- CLEAN SEAL LIP AND SEALING SURFACE ON CRANKSHAFT WITH CLEAN WIPING RAGS.
- 2. INSTALL SEAL PILOT (2) SUPPLIED WITH SEAL KIT ONTO CRANKSHAFT.

# **CAUTION**

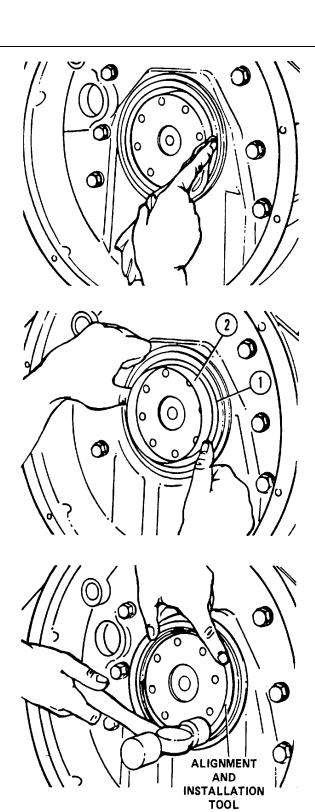
Always use the seal pilot (2) to install rear oil seal (1). Failure to do so could result in a damaged oil seal (1).

- 3. INSTALL OIL SEAL (1) OVER SEAL PILOT (2) AND ONTO CRANKSHAFT.
- 4. REMOVE SEAL PILOT (2) FROM CRANK-SHAFT.

# **CAUTION**

Tap alignment/installation tool at the 12, 3, 6, and 9 o'clock positions only. Striking the tool at other locations could damage the seal carrier.

- 5. USE ALIGNMENT/INSTALLATION TOOL SUPPLIED WITH SEAL KIT TO MOVE OIL SEAL (1) TO CORRECT DEPTH IN THE HOUSING.
  - Place alignment/installation tool supplied with rear seal kit onto crankshaft and against seal carrier with the flange of the tool away from the seal.
  - b. Use a hammer to tap seal into seal retainer until flange of tool is against seal retainer.
- 6. INSTALL FLYWHEEL, PARA. 3-12.



#### 3-11. CRANKSHAFT VIBRATION DAMPER - REPLACE

This task covers:

- a.Removal
- b.Cleaning
- c. Inspection
- d.Installation

#### **Initial Setup**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

#### **Equipment Condition**

Radiator removed, TM 10-3930-660-20. Drive belt removed, TM 10-3930-660-20.

#### **REMOVAL**

Remove four capscrews (1) and vibration damper (2).

#### **CLEANING**

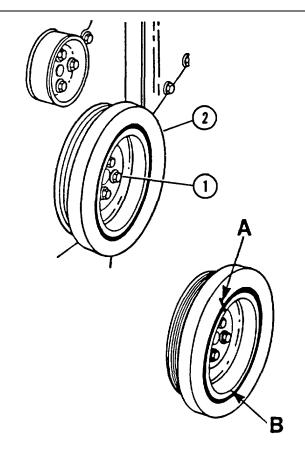
See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

- CHECK THAT INDEX LINES (A) ARE ALIGNED. IF INDEX LINES ARE MORE THAN 1/16 INCH APART, REPLACE VIBRATION DAMPER.
- 2. INSPECT RUBBER PART (B) OF DAMPER FOR DETERIORATION AND MISSING PIECES. REPLACE DAMPER IF DETERIORATION AND/OR MISSING PIECES ARE EVIDENT.
- SEE 'INSPECTION INSTRUCTIONS", PARA. 2-11.

# **INSTALLATION**

- 1. INSTALL VIBRATION DAMPER (2) AND CAPSCREWS (1).
- TORQUE CAPSCREWS (1) TO 101 LB. FT.



- 3. INSTALL DRIVE BELT, TM 10-3930-660-20.
- 4. INSTALL RADIATOR, TM 10-3930-660-20.

#### 3-11. FLYWHEEL - REPLACE

This task covers:

- a. Removal of Flywheel
- b.Cleaning
- c. Inspection
- d.Installation of Flywheel

#### **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common \$2 Less Power

Tool, Engine Barring

Lifting Device (Capacity 200-Lb.)

#### **Equipment Condition**

Engine removed, para. 3-3. Starting motor removed, TM 10-3930-660-20.

#### Materials/Parts

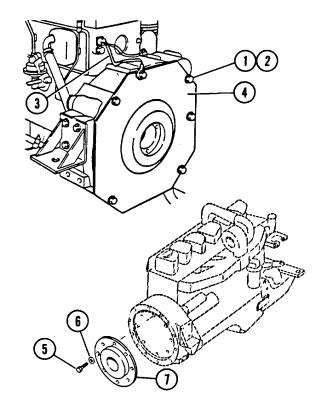
Capscrews (9) Lockwashers (2, 6) Loctite 242 (App. B, Item 41) Tags (app. B, Item 52) Washers (10)

# REMOVAL OF FLYWHEEL

- 1. REMOVE FLYWHEEL HOUSING COVER (4) AND COUPLING (7).
  - a. Identify and tag ether start thermostat ground wire (3).
  - b. Remove six capscrews (1) and lockwashers (2), ground wire (3), and flywheel housing cover (4). Discard lockwashers (2).
  - c. Use a thin wall socket to remove eight capscrews (5), lockwashers (6), and 10 inch coupling (7). Discard lockwashers (6).

#### **NOTE**

If necessary, install two capscrews (5) in tapped holes of coupling (7) to push coupling from flywheel.



# 3-12. FLYWHEEL - REPLACE (Cont'd)

# **WARNING**

Take necessary precautions to insure adequate personal safety while removing the flywheel. The flywheel weighs more than 50 pounds. To avoid personal injury, use a suitable lifting device and hoist to remove the flywheel.

# **CAUTION**

Do not use timing pin to lock the engine. Using timing pin as a locking device while loosening flywheel mounting hardware could damage the pin.

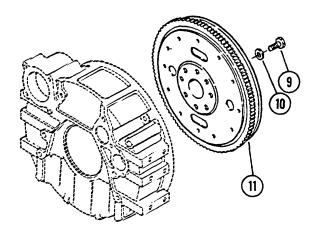
- 2. REMOVE FLYWHEEL (11) WHILE KEEPING THE CRANKSHAFT FROM TURNING.
  - a. Install two long capscrews in vibration damper. Use a bar between the long capscrews to hold crankshaft.
  - b. Attach a suitable lifting device and hoist, with a capacity of at least 200 pounds, to the flywheel.
  - c. Firmly hold barring tool to keep flywheel from turning. Loosen eight capscrews (9).
  - d. Remove barring tool. Remove eight capscrews (9), washers (10), and flywheel (11). Discard capscrews (9) and washers (10).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### INSPECTION

See Inspection Instructions, para. 2-11.

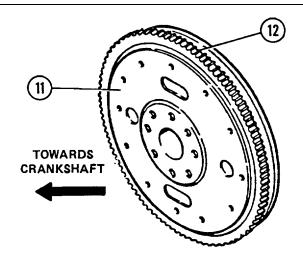


# 3-12. FLYWHEEL - REPLACE (Cont'd)

# **INSTALLATION OF FLWHEEL**

# **WARNING**

Take necessary precautions to insure adequate personal safety while installing the flywheel. The flywheel weighs more than 50 pounds. To avoid personal injury, use a suitable lifting device and hoist to install flywheel.



# 3-12. FLWHEEL - REPLACE (Cont'd)

# **CAUTION**

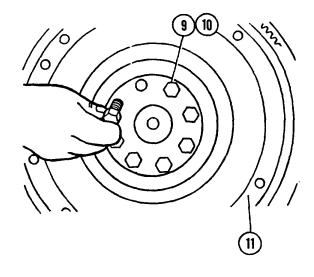
Do not use the timing pin to lock the engine. Use a barring tool to hold the engine crankshaft during flywheel installation. Using the timing pin as a locking device while tightening the flywheel mounting hardware could damage the pin.

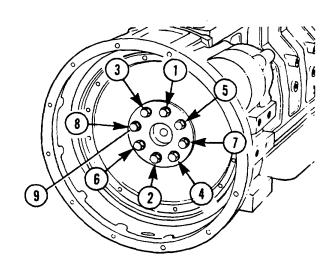
- 1. INSTALL FLYWHEEL (11). USE BARRING TOOL TO KEEP THE CRANKSHAFT FROM TURNING. USE NEW CAPSCREWS (9) AND WASHERS (10).
  - Attach a suitable lifting device and hoist, with a capacity of at least 200 pounds, to the flywheel.

# **CAUTION**

Install new capscrews each time flywheel is removed to help prevent possible engine failure.

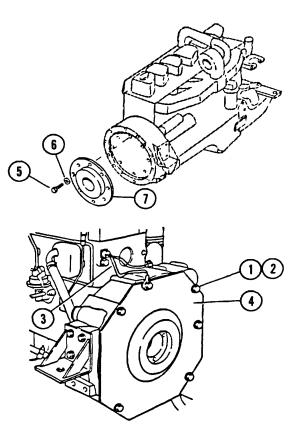
- Lift flywheel (11) against end of crankshaft and install eight new capscrews (9) and washers (10). Remove hoist and lifting device.
- c. Install barring tool between long capscrews in vibration damper.
- d. Firmly hold barring tool to keep flywheel from turning, and tighten capscrews (9), in the sequence shown, to 101 lb. ft. torque.
- e. Remove barring tool.





# 3-12. FLYWHEEL - REPLACE (Cont'd)

- 2. INSTALL FLYWHEEL HOUSING COVER (4) AND COUPLING (7).
  - a. Apply Loctite #242 to threads of capscrews (5).
  - b. Install 10 inch coupling (7), new lockwashers (6), and capscrews (5). Torque to 25 lb. ft. and let set for 24 hours before operating engine.
  - c. Install flywheel housing cover (4), ether start thermostat ground wire (3), and six new lockwashers (2) and capscrews (1).
- 3. INSTALL STARTING MOTOR, TM 10-3930-660-20.
- 4. INSTALL ENGINE, PARA 3-3.



#### 3-13. FLYWHEEL HOUSING AND COVER - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f Installation

# **INITIAL SETUP**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Lifting Device (Capacity 300 lbs.)

# **Equipment Condition**

Flywheel removed, para. 3-12.

# Materials/Parts

2 - Capscrews, M12 X 1.25 X 10 Gasket (6) Lint-Free Rags (App. B, Item 38) Oil Seal (8) O-Ring (3, 12).

#### **REMOVAL**

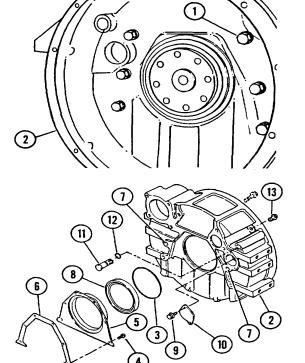
- 1. REMOVE FLYWHEEL HOUSING (2).
  - Attach a suitable lifting device and hoist to the flywheel housing.
  - b. Remove eight capscrews (1) and lift flywheel housing (2) from engine.
- 2. REMOVE REAR COVER (5).
  - a. Remove and discard O-ring (3).
  - b. Remove six capscrews (4) and rear cover (5).
  - c. Remove and discard gasket (6).

REMOVE TWO RING DOWELS (7) ONLY IF DAMAGED.

# **DISASSEMBLY**

1. REMOVE AND DISCARD REAR OIL SEAL (8).

Use a suitable driver tool to press rear oil seal (8) from rear cover (5). Discard seal (8).



# 3-13. FLYWHEEL HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

- 2. DISASSEMBLE FLYWHEEL HOUSING (2).
  - a. Remove two capscrews (9) and cover plate (10) from flywheel housing (2).
  - b. Remove O-ring plug (11) and O-ring (12). Discard O-ring (12).
  - c. Remove threaded plug (13).

# **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

ASSEMBLE FLYWHEEL HOUSING (2).

- a. Install threaded plug (13).
- b. Install O-ring plug (11) and new O-ring (12).
- c. Install cover plate (10) and two capscrews (9).

#### **INSTALLATION**

1. IF REMOVED, INSTALL TWO RING DOWELS (7).

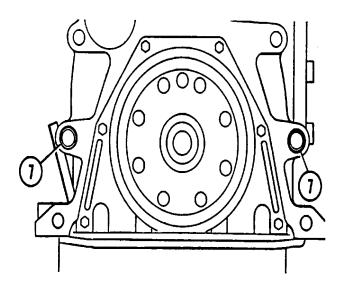
Drive two ring dowels (7) into cylinder block until they are against bottom of bore.

2. CLEAN AND DRY REAR CRANKSHAFT SEALING SURFACE.

Clean and dry rear crankshaft sealing surface with clean lint-free rags.

#### **NOTE**

The oil seal sealing surface on the crankshaft must be clean to help prevent seal leaks



# 3-13. FLYWHEEL HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

- 3. INSTALL NEW GASKET (6) AND REAR COVER (5).
  - a. Install new gasket (6) and rear cover (5) onto cylinder block.
  - b. Loosely install six capscrews(4)
- 4. ALIGN REAR COVER (5) TO CRANKSHAFT (B) USING SEAL KIT INSTALLATION AND ALIGNMENT TOOL.
  - Place installation and alignment tool supplied with oil seal kit over the crankshaft (B) and into the rear cover (5).
     This aligns the cover to the crankshaft.
  - b. Align rear cover (5) with both sides of the cylinder block oil pan rail until surfaces are flush. Tighten six capscrews (4) to 7 lb. ft.
  - Remove installation and alignment tool and trim gasket even with oil pan mounting surface at points "A".

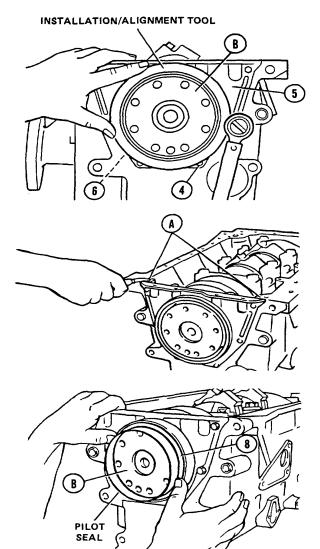
# **CAUTION**

The rear oil seal lip must be clean to help prevent seal leaks.

#### **CAUTION**

Always use the seal pilot to install rear seal. Failure to do so could result In a damaged seal.

- 5. INSTALL NEW REAR OIL SEAL (8) USING SEAL PILOT SUPPLIED WITH OIL SEAL KIT.
  - a. Wipe new oil seal lip clean with a clean lint-free rag.
     Install new oil seal (8) with seal pilot onto crankshaft
     (B).
  - b. Push seal onto crank and remove seal pilot.

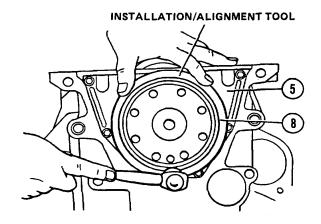


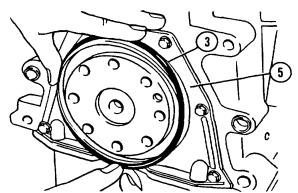
# 3-13. FLYWHEEL HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

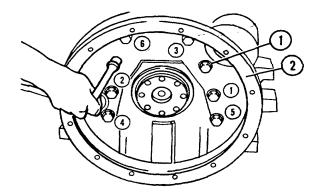
#### **CAUTION**

Tap alignment and installation tool at the 12, 3, 6, and 9 o'clock positions only. Striking the tool at other locations could damage the seal carrier.

- 6. POSITION NEW REAR OIL SEAL (8) TO CORRECT DEPTH IN REAR COVER (5) WITH INSTALLATION AND ALIGNMENT TOOL.
  - a. Place installation and alignment tool onto crankshaft and against oil seal (8) carrier.
  - b. Tap tool with a plastic hammer at the 12, 3, 6, and 9 o'clock positions to drive new oil seal (8) evenly into position and to prevent damaging the seal carrier.
  - c. Drive oil seal (8) into rear cover (5) until installation and alignment tool stops against the cover.
  - Remove installation and alignment tool from crankshaft.
- 7. INSTALL NEW O-RING (3) OVER REAR COVER (5).
- 8. INSTALL FLYWHEEL HOUSING.
  - a. Attach suitable lifting device and hoist to flywheel housing (2) and lift housing into position on engine.
  - b. Install eight capscrews (1). Tighten capscrews to 57 lb. ft. in the sequence shown.
- 9. INSTALL FLYWHEEL, PARA. 3-12.







#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

# Initial Setup

### Tools

Tool Kit, Automotive Mechanics

Tool Kit, Machinists: Post, Camp and Station

Shop Equipment, Automotive Maintenance, Common #2 Less Power

#### **Equipment Condition**

Connecting rod/piston assembly removed from engine, para. 3-15.

## Materials/Parts

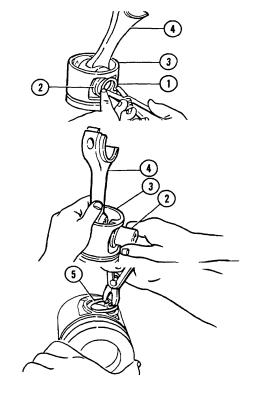
Detergent, Laundry (App. B, Item 9) Oil, Lubricating, Engine, OE/HDO-15/40 (App. B, Item 26) Piston Ring Set Solvent, Dry Cleaning, P-D-680 (App. B, Item 48)

#### **REMOVAL**

#### **NOTE**

Pistons do not have to be heated in order to remove piston pins.

- 1. REMOVE PISTON PIN (2).
  - a. Remove retaining ring (1).
  - b Remove piston pin (1) from piston (3).
  - c Separate piston (3) from connecting rod (4).
  - d Remove second retaining ring (5)



2. REMOVE AND DISCARD PISTON RINGS (6, 7 AND 8) AND OIL RING EXPANDER (9).

#### **CLEANING**

#### **NOTE**

Refer to Cleaning Instructions, para. 2-10, for general cleaning information and for appropriate warnings regarding use of solvents and compressed air.

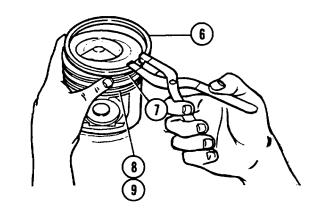
#### **CAUTION**

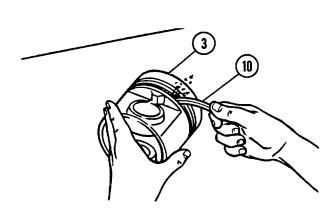
Do not use bead blast to clean pistons. Bead blasting may damage piston.

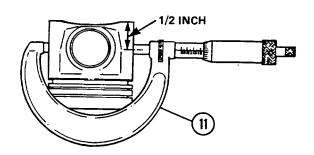
- SOAK PISTONS (3) IN DRY CLEANING SOLVENT P-D-680 TO REMOVE CARBON DEPOSITS.
- 2. WASH PISTONS IN A STRONG SOLUTION OF LAUNDRY DETERGENT AND HOT WATER, TO REMOVE CARBON RESIDUE. USE A STIFF BRISTLE BRUSH.
- 3. CLEAN RING GROOVES IN PISTON (3)
  USING SQUARE END OF A BROKEN PISTON
  RING (10). USE CARE TO AVOID
  SCRATCHING RING SEALING SURFACES
  IN PISTON GROOVES.
- CLEAN PISTONS AGAIN IN SOLUTION OF LAUNDRY DETERGENT AND HOT WATER.
- 5. RINSE PISTONS IN CLEAN, FRESH WATER AND DRY USING COMPRESSED AIR.

#### **INSPECTION**

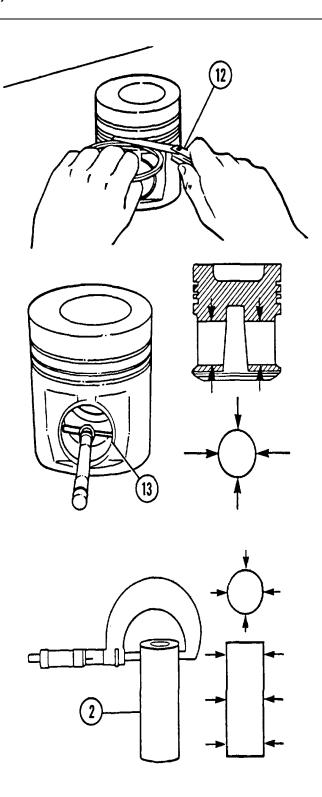
- VISUALLY INSPECT RING GROOVES, PISTON TOP, PISTON SKIRT AND PISTON PIN BORE FOR CRACKS OR OTHER DAMAGE AND FOR EXCESSIVE WEAR.
- 2. CHECK PISTON SKIRT DIAMETER USING AN INSIDE MICROMETER (11) AS SHOWN, AT A POINT APPROXIMATELY 1/2 INCH ABOVE BOTTOM EDGE OF PISTON. MINIMUM ALLOWABLE SKIRT DIAMETER IS 4.0088 INCH.





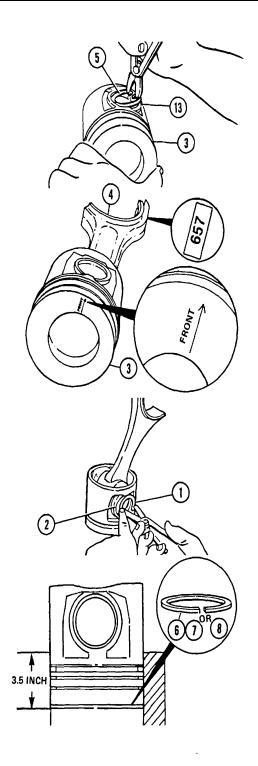


- 3. CHECK TOP PISTON RING FOR NICKS, CRACKS OR OTHER VISIBLE DEFECTS. RING CLEARANCE CHECK IS NOT REQUIRED FOR TOP PISTON RING.
- 4. CHECK RING CLEARANCE IN INTERMEDIATE AND OIL CONTROL RING GROOVES USING NEW RINGS AND A FEELER GAUGE (12) AS SHOWN. MAXIMUM ALLOWABLE CLEARANCES FOR THESE TWO GROOVES ARE:
  - a. Intermediate ring groove 0.006 inch.
  - b. Oil control ring groove 0.005 inch.
- 5. CHECK PISTON PIN BORE DIAMETER (13) AT FOUR POINTS NOTED. MAXIMUM ALLOWABLE BORE DIAMETER IS 1.5758INCH.
- 6. CHECK PISTON PIN (2) DIAMETER AT SIX POINTS AS SHOWN. MINIMUM ALLOWABLE

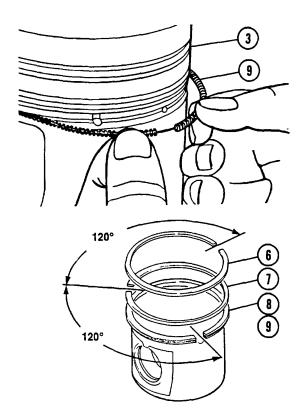


## **INSTALLATION**

- 1. INSTALL RETAINING RING (5) INTO GROOVE ON SIDE OF PISTON (3) MARKED FRONT.
- 2. LUBRICATE PISTON PIN (2) AND PIN BORE (13) WITH CLEAN ENGINE OIL.
- 3. ORIENT WORD, FRONT, ON TOP OF PISTON (3) AND NUMBER ON CONNECTING ROD (4) AS SHOWN, AND THEN INSTALL PISTON PIN (2).
- 4. PLACE EACH NEW PISTON RING (6, 7 AND 8), INDIVIDUALLY, INTO CYLINDERS TO A DEPTH OF 3.5 INCHES AND SQUARE RING IN BORE USING PISTON AS SHOWN.



- 6. MEASURE AND RECORD NEW PISTON RING GAPS WHILE RINGS ARE IN CYLINDERS. GAPS SHOULD BE AS FOLLOWS:
  - a. Top ring gap 0.0160 to 0.0275 inch.
  - b. Intermediate ring gap 0.0100 to 0.0215 inch.
  - c. Oil control ring gap 0.0100 to 0.0215 inch.
- 7. IF GAPS ARE EXCESSIVE, SELECT NEXT OVERSIZED PISTON RING SET.
- 8. IF GAPS ARE TOO CLOSE, AND NEW PISTON SLEEVES HAVE BEEN INSTALLED, BORE OUT PISTON SLEEVES AS NECESSARY TO ALLOW GAPS TO OPEN UP TO SPECIFICATION.
- 9. INSTALL OIL CONTROL RING EXPANDER (9) AND RINGS (6, 7 AND 8).
  - a. Place oil control ring expander(9) in bottom groove of piston (3).
  - b. Install oil control ring (8) over expander (9), with gap in oil control ring (8) positioned 1800 from gap in expander (9).
  - c. Install intermediate ring (7), placing its gap at a point 1200 from gap in oil control ring (8).
  - d. Install top ring (6), placing its gap at a point 1200 from gap in intermediate ring (7).
- 10. INSTALL PISTONS AND CONNECTING RODS, PARA. 3-15.



### 3-15. CONNECTING RODS AND BEARINGS - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

### **Tools**

Tool Kit, Automotive Mechanics

Tool Kit, Machinists: Post, Camp and Station

Inside/Outside Micrometer

Shop Equipment, Automotive Maintenance, Common #2 Less Power

## **Equipment Condition**

Cylinder head removed, para. 3-7. Oil pan removed, para. 3-20. Oil pump inlet tube removed, para. 3-21.

## Materials/Parts

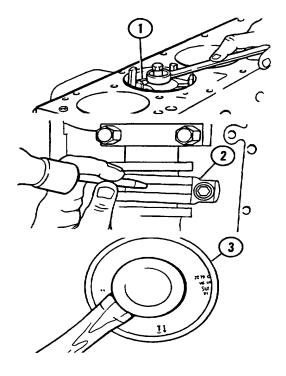
Bearing Set, Piston Rod Capscrews (4) Detergent, Laundry (App. B, Item 9) Lubriplate 105 (App. B, Item 16) Oil, Engine Lubricating (App. B, Item 26)

## **REMOVAL**

## **CAUTION**

Maximum allowable cylinder bore diameter is 4.0203 inches. Make sure that ridge reamer does not gouge into cylinder bore or remove more metal than necessary.

- IF NECESSARY, REMOVE RIDGE FROM TOP OF CYLINDERS USING RIDGE REAMER (1).
- 2. MARK EACH ROD BEARING CAP (2) AND MATCHED PISTON (3) WITH CYLINDER NUMBER. USE A HAMMER AND STEEL NUMBER STAMPS.



# 3-15. CONNECTING RODS AND BEARINGS - REPLACE (Cont'd)

3. REMOVE CAPSCREWS (4), ROD BEARING CAP (2) AND ROD BEARINGS (5). DISCARD ROD BEARINGS (5). DISCARDCAPSCREWS (4).

### **NOTE**

Do not reuse connecting rod capscrews (4).

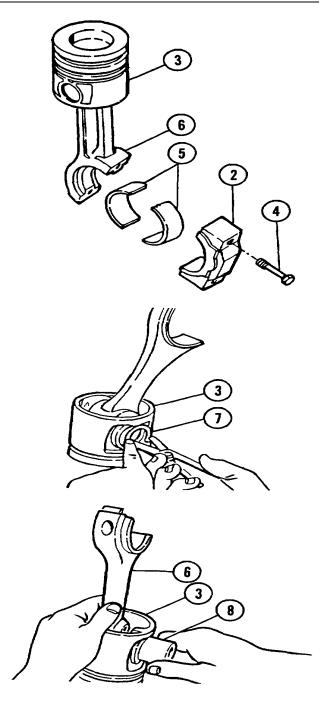
- 4 REMOVE PISTON (3) AND CONNECTING ROD (6) ASSEMBLY BY PUSHING OUT THROUGH TOP OF CYLINDER BLOCK.
- 5. REMOVE CONNECTING ROD (6) FROM PISTON (3).
  - a. Remove retaining ring (7) from front side of piston (3).
  - b. Remove piston pin (8) from piston (3) and connecting rod (6) to remove connecting rod (6).

#### **CLEANING**

#### **NOTE**

Refer to Cleaning Instructions, para. 2-10, for general cleaning information and for appropriate warnings regarding use of solvents and compressed air.

- WASH CONNECTING RODS (6) IN A STRONG SOLUTION OF LAUNDRY DETERGENT AND HOT WATER.
- 2 RINSE CONNECTING RODS (6) IN FRESH, CLEAN WATER AND WIPE DRY USING WIPING RAGS.



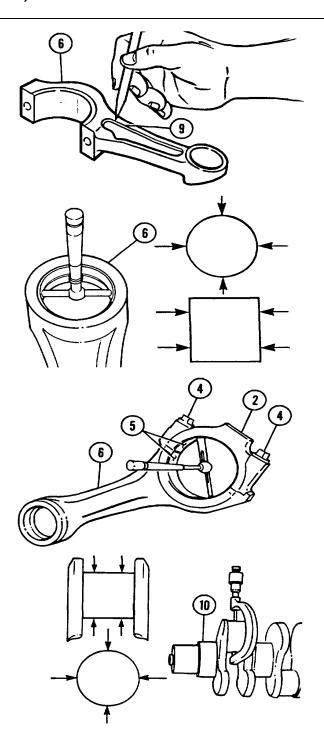
## 3-15. CONNECTING RODS AND BEARINGS - REPLACE (Cont'd)

#### **INSPECTION**

- VISUALLY INSPECT CONNECTING RODS (6) FOR DAMAGE OR OBVIOUS WEAR.
- 2. CHECK I-BEAM SECTION (9) OF CONNECTING RODS (6) FOR DENTS OR OTHER DAMAGE. ANY DAMAGE IN THIS AREA CAN CAUSE STRESS WHICH WILL LEAD TO BREAKAGE.
- 3. MEASURE I.D. OF PISTON PIN BORE IN CONNECTING ROD (6), AT FOUR POINTS AS SHOWN, TO CHECK FOR WEAR. TAKE AVERAGE OF ALL READINGS. AVERAGE READING MUST NOT EXCEED RANGE FROM 1.5769 TO 1.5784 INCH.
- 4. CHECK ROD BEARING CLEARANCE.
  - a. Assemble connecting rod (6), rod bearings (5) and cap (2).
  - b. Install capscrews (4) and tighten to 73 lb. ft.
  - c. Record smallest diameter measured at various points around bore.
  - Measure and record mean diameter of rod journal on crankshaft (10). Take four readings on each journal at points noted.
  - e. Subtract rod journal mean diameter, STEP d, from smallest rod bearing diameter, STEP c, to determine rod bearing clearance.

#### **NOTE**

Maximum allowable rod bearing clearance is 0.0035 inch. Select required undersized bearing set to compensate for excessive rod bearing clearance.



## 3-15. CONNTING RODS AND BEARINGS - REPLACE (Cont'd)

## **INSTALLATION**

#### **NOTE**

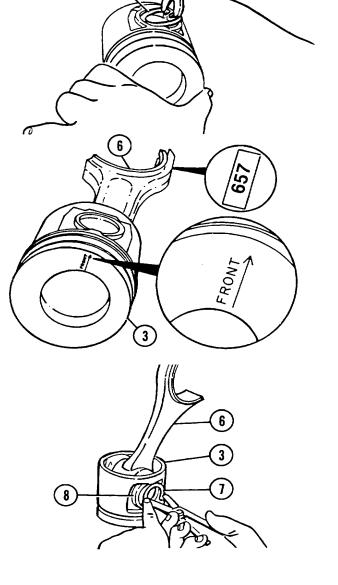
If required, replace piston rings (para. 3-14), before proceeding.

- 1. ASSEMBLE CONNECTING ROD (6) TO PISTON (3).
  - a. Liberally apply engine lubricating oil to piston pin
    (8) and to piston pin bores in connecting rod (6) and in piston (3).
  - Install retaining ring (11) on side of piston marked, FRONT.
  - c. Orient piston (3) and connecting rod (6) so word, FRONT, on top of piston (3) and number stamped on connecting rod are positioned as shown.
  - d. Install piston pin (8) through bores in piston (3) and in connecting rod (6).
  - e. Install retaining ring (7).
- 2. INSTALL PISTON (3) AND CONNECTING ROD (6) ASSEMBLY.
  - a. Apply engine lubricating oil to cylinder bores, piston rings and piston skirts.

## **CAUTION**

If a strap-type ring compressor is used in STEP b, take care not to hook strap on a ring gap, as doing so could cause ring to break.

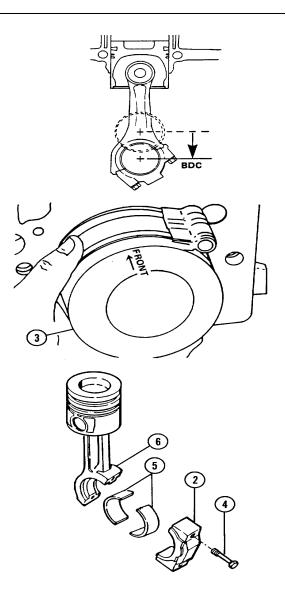
b. Compress piston rings using a suitable ring compressor.



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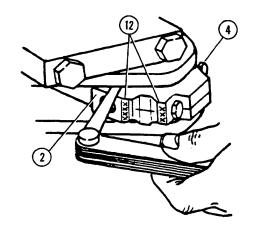
# 3-15. CONCTING RODS AND BEARINGS - REPLACE (Cont'd)

- Bar crankshaft over so rod journal for piston and connecting rod assembly being installed is at bottom dead center (BDC).
- d. Install piston (3) and connecting rod (6) assembly through top of cylinder bore, using care not to damage cylinder liner walls. Make sure that side of piston (3) containing word, FRONT, faces front (fan end) of engine.
- e. Continue to push piston (3) into cylinder bore until top of piston (3) is approximately 2 in. below top surface of cylinder block.
- f. Repeat above procedure until all six piston and connecting rod assemblies are installed.
- g. Obtain proper sized rod bearing set, according to rod bearing clearance measurement, above.
- h. Install new rod bearings (5) in
- i. Apply light coat of Lubriplate 105 to rod bearing (5) bearing surfaces.
- j. Grasp bottom of connecting rod (6) and pull downward onto crankshaft rod journal.
- Install bearing caps (2) with four-digit numbers (12) stamped on bearing caps (2) and on connecting rods (6), at parting line, towards oil cooler side of engine.



# 3-15. CONNCTING RODS AND BEARINGS - REPLACE (Cont'd)

- I. Apply engine lubricating oil to threads and under heads of capscrews (4).
- m. Tighten capscrews (4) in three increments.
  - (1) First increment 26 lb. ft.
  - (2) Second increment 52 lb. ft.
  - (3) Third increment 73 lb. ft.
- 3. AS BEARING CAPS (2) ARE INSTALLED, MANUALLY ROTATE CRANKSHAFT TO ENSURE THAT CRANKSHAFT ROTATES FREELY. IF CRANKSHAFT FAILS TO ROTATE FREELY AT SOME POINT, CHECK FOR INCORRECT INSTALLATION OR INCORRECT SIZE OF ROD BEARINGS (5).
- 4. REPEAT STEPS 2 AND 3 UNTIL ALL SIX PISTON AND CONNECTING ROD ASSEMBLIES ARE INSTALLED.
- 5. MEASURE CONNECTING ROD SIDE PLAY AT EACH CONNECTING ROD ASSEMBLY.
  - a. Measure connecting rod side play.
  - b. Wear tolerance is 0.012 inch maximum.
  - c. If side play exceeds wear tolerance stated in step b, replace connecting rod and connecting rod cap.
- 6. INSTALL OIL PUMP INLET TUBE, PARA. 3-21, OIL PAN, PARA. 3-20 AND CYLINDER HEAD. PARA. 3-7.



#### 3-16. ROCKER ARM ASSEMBLY - REPLACE/REPAIR

### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Tool Kit, Machinists: Post, Camp and Station

Tool Kit, Automotive Maintenance Common \$2 Less Power

Inside/Outside Micrometer

# **Equipment Condition**

Rocker arm covers removed, TM 10-3930-660-20. Negative battery cable disconnected, TM 10-3930-660-20.

## Materials/Parts

Engine Lubricating Oil (App. B, Item 26)

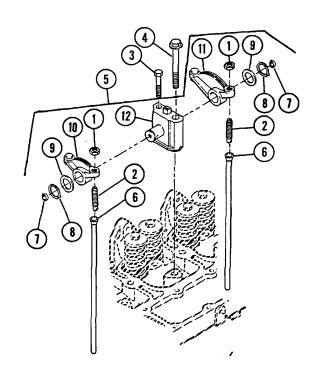
## **REMOVAL**

1. REMOVE ROCKER ARM ASSEMBLY (5).

#### NOTE

Tag or mark rocker arm assemblies, to include push rods, so assemblies can be installed into the same position from which they were removed.

- a. Loosen two adjusting screw nuts (1).
- b. Loosen two adjusting screws (2).
- c. Remove capscrew (3) and capscrew (4), and remove rocker arm assembly (5).
- d. Repeat STEPS a through c for the other five rocker arm assembly sets (5).
- 2. REMOVE 12 PUSH RODS (6).



# 3-16. ROCKER ARM ASSEMBLY - REPLACE/REPAIR (Cont'd)

#### **DISASSEMBLY**

#### **NOTE**

Keep each rocker arm assembly together as a set.

DISASSEMBLE ROCKER ARM ASSEMBLY (5).

#### NOTE

Remove expansion plug (7) only if necessary.

a. Remove two expansion plugs (7), retaining rings (8), and washers (9).

#### **CAUTION**

Do not remove shaft from support (12). The support and shaft <u>must</u> be replaced as an assembly.

- b. Remove intake rocker arm (10) and exhaust rocker arm (11) from support (12).
- c. Remove nuts (1) and adjusting screws (2) from rocker levers (10 and 11).
- d. Repeat STEPS a, b, and c for the other five rocker arm assemblies (5).

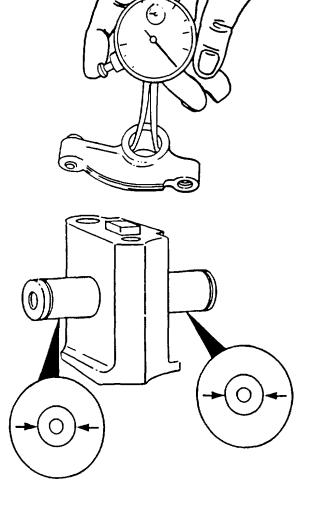
#### **CLEANING**

See Cleaning Instructions, para. 2-10.

## **INSPBCTION**

- 1. SEE "INSPECTION INSTRUCTIONS", PARA. 2-11.
- 2. MEASURE ROCKER ARM BORE.

Maximum Allowable Diameter: 0.750 inch



## 3-16. ROCKER ARM ASSEMBLY - RIEPACE/REPAIR (Cont'd)

MEASURE ROCKER ARM SUPPORT SHAFT DIAMETER.

Minimum Allowable Diameter: 0.746 inch

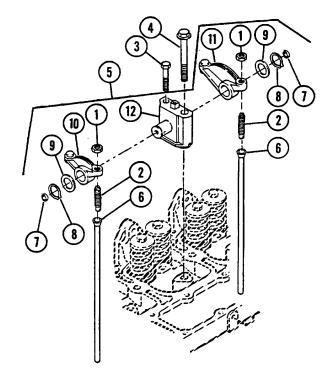
#### **ASSEMBLY**

#### **NOTE**

Be sure to assemble intake rocker arm (10) and exhaust rocker arm (11) in the correct location.

ASSEMBLE ROCKER ARM ASSEMBLY (5).

- a. Assemble adjusting screws (2) and nuts (1) to rocker levers (10 and 11).
- b. Lubricate both ends of support shaft with engine lubricating oil.
- c. Check to make sure adjusting screws (2) are completely backed out.
- d. Assemble intake rocker arm (10) and exhaust rocker arm (11) onto support (12) shaft.
- e. Install two washers (9), retaining rings (8J, and new expansion plugs (7) if removed.
- Repeat STEPS a through e for the other five rocker arm assemblies (5).



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TM 10-3930-660-34

## 3-16. ROCKER ARM ASSEMBLY - REPLACE/REPAIR (Cont'd)

#### INSTALLATION

- 1. INSTALL 12 PUSH RODS (6) INTO SAME POSITION IN ENGINE AS ORIGINALLY PLACED. LUBRICATE PUSH ROD SOCKETS WITH CLEAN ENGINE LUBRICATING OIL.
- 2. INSTALL ROCKER ARM ASSEMBLY (5) IN ORIGINAL POSITION. TIGHTEN CAPSCREWS (4) TO FINAL TORQUE VALUE IN THREE STEPS.
  - Place rocker arm assembly (5) onto cylinder head.

- b. Apply clean engine lubricating oil to threads and under the heads of capscrews (3 and 4).
- c. Install six M8 capscrews (3) and six M12 capscrews (4). Tighten M12 capscrews (4) to final torque value in the three steps:

Step 1: 29 lb. ft. Step 2: 62 lb. ft. Step 3: 92 lb. ft.

- d. Tighten M8 capscrews (3) to 18 lb. ft.
- e. Repeat STEPS a through e for the other five rocker arm assemblies (5).
- 3. ADJUST VALVES, TM 10-3930-660-20.
- 4. INSTALL ROCKER ARM COVERS, TM 10-3930-660-20.

# 3-17. VALVE TAPPETS - REPLACE

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

# Initial Setup

Tools

Shop Equipment, Automotive Maintenance, Common #2

Magnet

**Equipment Condition** 

Camshaft removed, para. 3-18. Oil pan removed, para. 3-20.

Materials/Parts

Lubriplate 105 (App. B, Item 16)

## **NOTE**

If a new camshaft is being installed, all tappets must be replaced.

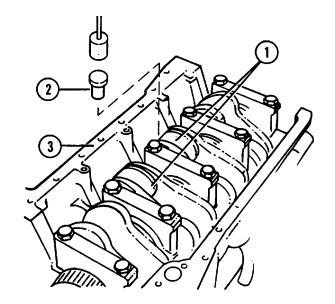
# **REMOVAL**

1. TURN ENGINE STAND SO CRANKSHAFT (1) IS FACING UP.

# **CAUTION**

Be careful not to drop the tappets (2) into the bottom of the pistons during tappet removal as this could damage the pistons.

2. USE A MAGNET TO REMOVE TAPPETS (2) FROM CYLINDER BLOCK (3).



# 3-17. VALVE TAPPETS - REPLACE (Cont'd)

#### INSPECTION

- 1. SEE "INSPECTION INSTRUCTIONS", PARA. 2-11.
- 2. INSPECT TAPPETS.

Inspect socket, stem and face for excessive wear and other damage.

Inspection Point A	Indication Normal wear
B & C	Abnormal wear, do not reuse.

3. MEASURE TAPPET BORES. IF TAPPET BORES IN CYLINDER BLOCK ARE NOT WITHIN SPECIFIED TOLERANCE, THE ENGINE MUST BE REBUILT.

Wear Limit Tolerance 0.630 - 0.632 inch

4. CHECK TAPPET DIMENSIONS.

D (Minimum Diameter) = 0.627 inch

Check tappet diameter in four places: 42 mm from face, 13 mm from face, and 900 to each measurement.

## **INSTALLATION**

 TURN ENGINE STAND SO CRANKSHAFT (1) IS FACING UP

# **CAUTION**

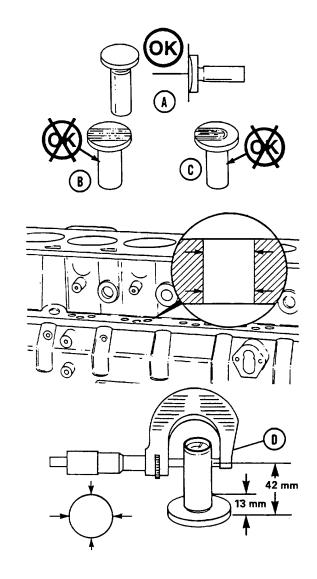
Be careful not to drop the tappets (2) into the bottom of the pistons during tappet installation as this could damage the pistons.

- 2. APPLY LUBRIPLATE 105 TO OUTSIDE DIAMETER OF TAPPET (2).
- 3. USE A MAGNET TO INSTALL TAPPETS (2) INTO CYLINDER BLOCK (3).

#### NOTE

If new tappets were installed, a new camshaft must also be installed.

4. INSTALL CAMSHAFT, PARA. 3-18.



5. INSTALL OIL PAN, PARA. 3-20.

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

## **Tools**

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Gloves, Insulated

## **Equipment Condition**

Fuel transfer pump removed, TM 10-3930-660-20 Engine removed, para. 3-3 Front housing cover removed, para. 3-19. Rocker lever arms removed, para. 3-16.

## Materials/Parts

Lubriplate 105 (app. B, Item 16)

# **REMOVAL**

#### **NOTE**

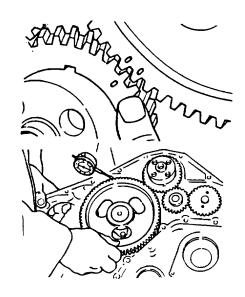
If new tappets were installed, the camshaft and camshaft bushing(s) must be replaced.

1. TURN CRANKSHAFT TO ALIGN TIMING MARKS ON CAMSHAFT GEAR WITH TIMING MARKS ON CRANKSHAFT GEAR.

#### **NOTE**

When measuring camshaft gear backlash, hold the camshaft gear and the crankshaft gear to avoid getting a false backlash reading.

- a. Measure camshaft gear backlash using a dial indicator as shown.
- b. Record measured backlash for reference.

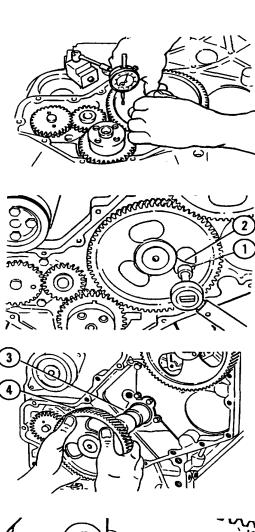


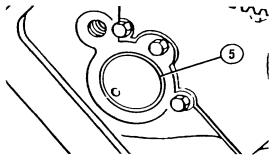
- Measure camshaft end play using a dial indicator positioned on a machined surface of the camshaft gear. Record indicator reading for reference
- TO PREVENT TAPPETS FROM DROPPING OUT OF THE CYLINDER BLOCK WHEN CAMSHAFT IS REMOVED, TURN ENGINE STAND SO THE CRANKSHAFT IS FACING UP.
- REMOVE CAMSHAFT GEAR AND CAMSHAFT AS AN ASSEMBLY.
  - a. Remove two capscrews (1) from thrust plate (2) and remove thrust plate.
  - b. Slowly and carefully remove camshaft (3) and gear (4), being careful not to damage the camshaft lobes and bearing journals, and camshaft bores in the cylinder block. It may be necessary to slowly turn the camshaft, during removal, to allow lobes to clear the tappets.

#### **NOTE**

If a new camshaft is to be installed, or if the camshaft bushing is damaged or dimensions exceed specified tolerance (see INSPECTION), the camshaft bushing, and all service bushings that may be installed in the other cam bores, must be replaced.

 IF NECESSARY, REMOVE CAMSHAFT BUSHING (5) AND ALL CAM SERVICE BUSHINGS USING THE UNIVERSAL BUSHING INSTALLATION TOOL.





## **DISASSEMBLY**

- USE A PRESS TO PUSH GEAR (4) FROM CAMSHAFT (3).
- 2. REMOVE KEY (6) FROM CAMSHAFT.
- 3. USE CROCUS CLOTH TO REMOVE ALL BURRS AND SMOOTH ANY ROUGH SURFACES ON THE CAMSHAFT THAT COULD HAVE BEEN CAUSED BY GEAR REMOVAL.

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

## **INSPECTION**

- 1. INSPECT CAMSHAFT BUSHING AND CAMSHAFT BORES IN CYLINDER BLOCK.
  - a. Inspect camshaft bushing and camshaft bores for burrs, scoring, grooves, and pitting.
  - b. Measure front camshaft bushing I.D. Acceptable range is 2.1295 to 2.1314 in.

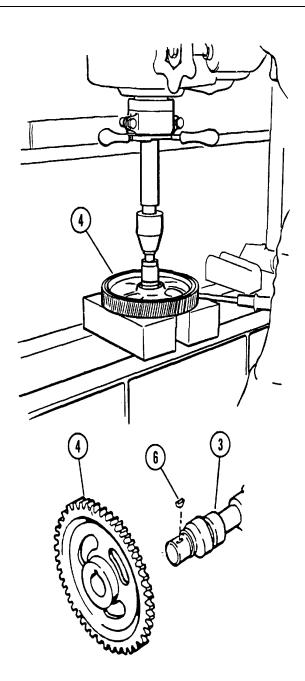
## **NOTE**

If intermediate and rear camshaft bores have service bushings installed, the I.D. dimension must be within the tolerance specified above in step b.

c. Measure intermediate and rear camshaft bores I.D. Acceptable bore I.D. range is 2.1295 to 2.1314 in. If bores are worn beyond this specification, the block must be machined and service bushings installed, or the block must be replaced. Refer to Depot level maintenance.

## NOTE

If new valve tappets are being installed, the camshaft and camshaft bushing must be replaced



#### 2. INSPECT CAMSHAFT.

- Inspect fuel lift pump lobe, valve lobes and camshaft bearing journal for cracking, pitting or other defects.
- b. Measure bearing journal diameter. Minimum allowable diameter is 2.1245 in. (53.962 mm).
- c. Measure valve lobe diameters at peak of lobe. Minimum allowable intake valve lobe diameter at peak of lobe is 1.852 in. (47.040 mm). Minimum allowable exhaust valve lobe diameter at peak lobe is 1.841 in. (46.770 mm).
- d. Measure fuel lift pump lobe diameter. Minimum allowable fuel lift pump lobe diameter is 1.398 in. (35.5 mm).

#### 3. INSPECT CAMSHAFT GEAR.

- a. Discard camshaft gear if measured backlash (REMOVAL, Step Ia.) is not 0.003 to 0.013 in. (0.08 to 0.33 mm).
- Inspect gear teeth for damage or excessive wear.
- c. Check for cracks at roots of gear teeth.

#### 4. INSPECT THRUST PLATE.

- a. Examine thrust plate for damage, distortion or excessive wear.
- b. Discard thrust plate if measured camshaft end play (Removal, step 1a.) is not 0.007 to 0.011 in. (0.17 to 0.29 mm). Also check for enlarged thrust plate slot in camshaft if end play is excessive.

## **ASSEMBLY**

- 1. INSTALL KEY (6) IN CAMSHAFT (3).
- 2. INSTALL GEAR (4).
  - a. Apply Lubriplate 105 to gear mounting surface of camshaft (4).
  - b. Heat gear (4) in an oven to 2500F for 45 minutes.

# **WARNING**

Wear protective gloves to handle gear. Gear is hot and can cause severe burns.

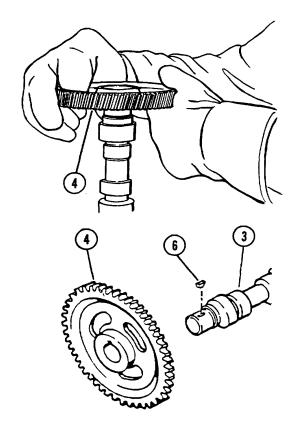
c. Install gear (4) on camshaft (3) with timing marks away from camshaft and gear tight against shoulder of camshaft.

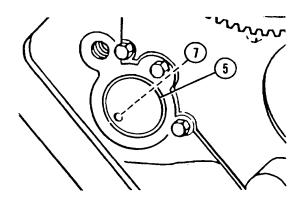
# **INSTALLATION**

## **NOTE**

If a new camshaft is being installed, a new camshaft bushing must be installed.

- 1. INSTALL CAMSHAFT BUSHING (5).
  - a. Mark location of oil hole (7) in camshaft bore using felt pen.
  - b. Place camshaft bushing (5) in its bore, taking care to align oilcx hole in bushing with oil hole (7) in camshaft bore.
  - c. Install camshaft bushing (5), using universal bushing installation tool, until bushing is flush with face of cylinder block.



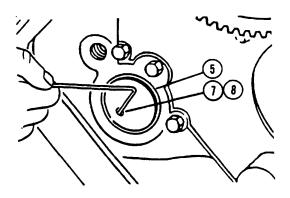


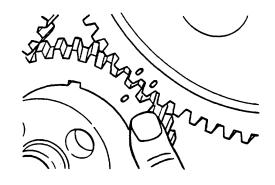
d. Check oil hole alignments by inserting a 0.128 inch diameter rod into bushing oil hole (8) and insuring that rod can also enter oil hole (7) in camshaft bore. Remove and reinstall camshaft bushing (5) if oil hole alignment is unsatisfactory.

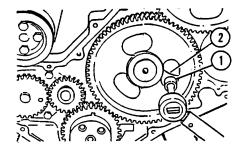
#### **NOTE**

The specified rod diameter represents the minimum sized oil passage required for adequate camshaft bushing lubrication.

- 2. APPLY LUBRIPLATE 105 TO CAMSHAFT BORES IN CYLINDER BLOCK AND TO LOBES OF CAMSHAFT.
- 3. INSTALL CAMSHAFT/GEAR/THRUST PLATE.
  - a. Position camshaft/gear/thrust plate in cylinder block.
  - b. Align timing marks on camshaft gear with timing mark on crankshaft gear.
  - c. Install capscrews (1) in thrust plate (2) and tighten to 216 in. lb. (24 N.m).
- 4. INSTALL ROCKER ARM LEVERS, PARA. 3-16.
- 5. INSTALL FUEL TRANSFER PUMP, TM 10-3930-660-20.
- 6. INSTALL FRONT HOUSING COVER, PARA. 3-19.
- 7. INSTALL OIL PAN, PARA. 3-20.







# 3-19. HOUSING AND COVER - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

### Initial Setup

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

Engine removed, para. 3-3. Tachometer drive removed, TM 10-3930-660-20. Fan and fan belt removed, TM 10-3930-660-20.

#### Materials/Parts

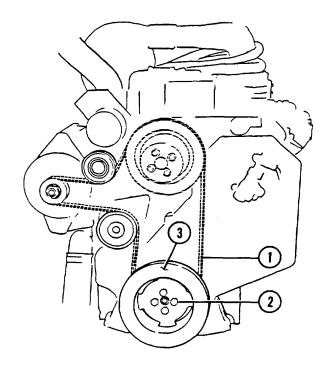
Gaskets (8, 11, 23) Loctite #277 (App. B, Item 44) Oil Seal (13) O-Ring (19) Rectangular Ring Seal (17)

# **REMOVAL**

1. REMOVE FOUR CAPSCREWS (1) AND VIBRATION DAMPER (2).

## **NOTE**

Capscrews which retain the gear housing and cover are of three sizes. Note sizes and locations of capscrews during removal to ensure proper assembly.

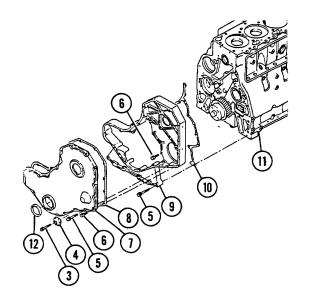


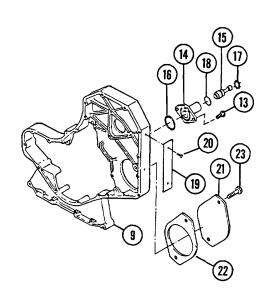
# 3-19. FRONT HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

- 2. REMOVE LONG CAPSCREW (3) AND BELT GUIDE (4).
- 3. REMOVE EIGHT CAPSCREWS (5) AND ELEVENSHORT CAPSCREWS (6) FROM GEAR COVER (7).
- 4. REMOVE GEAR COVER (7) AND GASKET (8). DISCARD GASKET (8).
- 5. REMOVE CAMSHAFT AND TIMING GEAR, PARA. 3-18.
- 6. REMOVE FUEL INJECTION PUMP, PARA. 4-4.
- 7. REMOVE TWO CAPSCREWS (5) AND FIVE SHORT CAPSCREWS (6) FROM GEAR HOUSING (9).
- 8. REMOVE GEAR HOUSING (9) AND GASKET (10). DISCARD GASKET (10).
- USE A GASKET SCRAPER TO REMOVE OLD GASKET MATERIAL FROM CYLINDER BLOCK (11) AND GEAR HOUSING (9).

## **DISASSEMBLY**

- IF NECESSARY, REMOVE OIL SEAL (12) FROM GEAR COVER (7) WITH A SUITABLE PULLER OR DRIVER.
- REMOVE TWO CAPSCREWS (13) WHICH RETAIN THE TIMING PIN HOUSING (14).
- 3. REMOVE TIMING PIN (15) AND HOUSING (14) AS AN ASSEMBLY.
- 4. REMOVE RECTANGULAR RING SEAL (16) FROM HOUSING (14). DISCARD RECTANGULAR RING SEAL (16).
- REMOVE RETAINING RING (17) FROM HOUSING (14).
- 6. REMOVE TIMING PIN (15) FROM HOUSING (14).
- 7. REMOVE O-RING (18). DISCARD O-RING (18).





# 3-19. FRONT HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

- 8. IF NECESSARY, REMOVE DATAPLATE (19) FROM GEAR HOUSING (9) BY REMOVING TWO DRIVE SCREWS (20).
- 9. IF NECESSARY, REMOVE COVER PLATE (21)
  AND GASKET (22) FROM BACK OF GEAR
  HOUSING (9) BY REMOVING TWO CAPSCREWS
  (23). DISCARD GASKET (22).

## **CLEANING**

See Cleaning Instructions, para. 2-10.

## INSPECTION

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

# **CAUTION**

If a new housing is installed, the timing pin assembly must be accurately located. Failure to do so could result in improper timing adjustment.

- IF REMOVAL WAS NECESSARY, INSTALL COVER PLATE (21) AND NEW GASKET (22) ONTO BACK OF GEAR HOUSING AND RETAIN WITH TWO CAPSCREWS (23).
- IF REMOVAL WAS NECESSARY, INSTALL DATAPLATE (19) ONTO GEAR HOUSING (9) AND RETAIN WITH TWO DRIVE SCREWS (20).
- 3. INSTALL NEW O-RING (18) INTO HOUSING (14).
- 4. INSTALL TIMING PIN (15) INTO HOUSING (14).
- 5. INSTALL RETAINING RING (17) INTO HOUSING (14).
- 6. INSTALL NEW RECTANGULAR RING SEAL (16) INTO HOUSING (14).

# 3-19. FRONT HOUSING AND COVER - REPLACE/REPAIR (Cont'd)

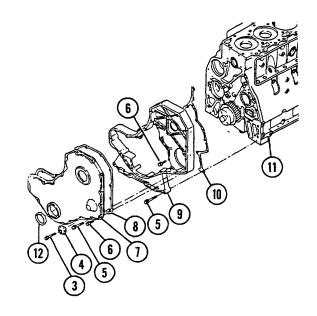
#### INSTALLATION

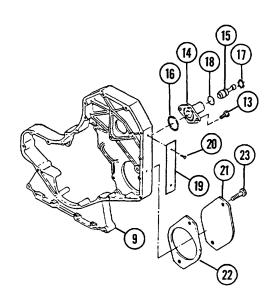
- INSTALL NEW GASKET (10) AND GEAR HOUSING (9) ONTO CYLINDER BLOCK (11). INSTALL TWO CAPSCREWS (5) AND FIVE SHORT CAPSCREWS (6). TIGHTEN CAPSCREWS TO 216 IN. LB.
- INSTALL CAMSHAFT AND TIMING GEAR, PARA. 3-18.
- 3. INSTALL TIMING PIN (15) AND HOUSING (14)
  ONTO GEAR HOUSING (9) AS AN ASSEMBLY.
  INSTALL TWO CAPSCREWS (13) FINGER
  TIGHT. HOLD PIN (15) IN AND ENGAGE HOLE IN
  CAMSHAFT GEAR TO ENSURE PROPER
  ALIGNMENT. TORQUE CAPSCREWS (13) TO 48
  IN. LB.
- 4. PULL TIMING PIN (15) OUT OF CAMSHAFT GEAR.
- 5. INSTALL FUEL INJECTION PUMP, PARA. 4-4.

### CAUTION

Lips of seal (12) and seal surface on crankshaft should be clean and free of oil prior to installation. Failure to clean surfaces could cause oil to leak at seal (12).

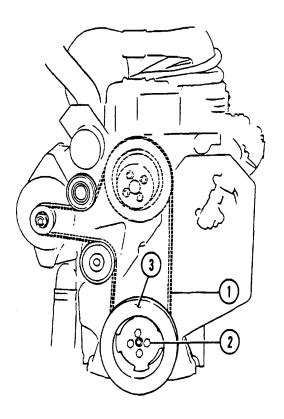
- 6. IF NEW SEAL (12) IS TO BE INSTALLED:
  - a. Install cover (7) and new gasket (8) onto housing (9) and retain with eight capscrews (5) and eleven short capscrews (6). Install capscrews in locations noted at disassembly. Do not tighten capscrews at this time.
  - b. Install alignment/installation tool from seal kit onto crankshaft end and into seal bore in gear cover (7) to align cover (7) with crankshaft end.
  - c. Torque capscrews (5) and (6) to 216 in. lb.





# 3-19. FRONT HOUSING AND COVER - REPIACE/REPAIR (Cont'd)

- d. Apply a bead of Loctite #277 to outside of new seal (12).
- e. Press seal (12) and seal pilot onto crankshaft end.
- f. Remove seal pilot from seal (12).
- g. Use alignment/installation tool included in seal kit to drive seal to correct depth in cover (7) bore.
- 7. IF OLD SEAL (12) IS TO BE RE-USED:
  - a. Install seal pilot from seal kit into inside diameter of seal (12) to protect lips of seal (12) during installation.
  - b. Install new gasket (8) onto housing (9).
  - c. Install seal (12) and cover (7) onto housing (9) as an assembly.
  - d. Install eight capscrews (5) and eleven capscrews (6) through gear cover (7) and into gear housing (9). Torque capscrews to 216 in. lb.
- 8. INSTALL CAPSCREW (3) AND BELT GUIDE (4). TORQUE CAPSCREW (4) TO 216 IN. LB.
- INSTALL VIBRATION DAMPER (2) AND RETAIN WITH FOUR CAPSCREWS (1). TIGHTEN CAPSCREWS (1) EVENLY TO 101 LB. FT.
- INSTALL FAN AND DRIVE BELT, TM 10-3930-660-20.
- 11. INSTALL TACHOMETER DRIVE, TM 10-3930-660-20.
- 12. INSTALL ENGINE, PARA. 3-3.



## 3-19.1. PUSH ROD COVER - REPLACE

This task covers:

- a. Removal
- b. Installation

## **INITIAL SETUP**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

## **Equipment Condition**

Fuel filter assembly removed, TM 10-3930-660-20. Fuel injection pump removed, para. 4-4.

# Materials/Parts

Gasket (7) Grommet Seals (5) K & W Copper Coat 1504 (App. B, Item 14)

#### Note

The push rod cover is accessed through the right-hand engine access door.

#### **REMOVAL**

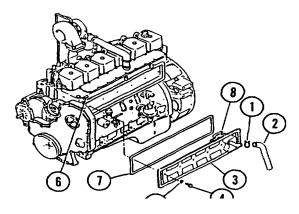
- REMOVE SPRING CLAMP (1) FROM HOSE (2) AND REMOVE HOSE (2) FROM PUSH ROD COVER (3).
- 2. REMOVE SIX CAPSCREWS (4) WITH SIX GROMMET SEALS (5) WHICH SECURE PUSH ROD COVER (3) TO ENGINE BLOCK (6). DISCARD GROMMET SEALS (5).
- REMOVE ROD COVER (3) AND PUSH ROD COVER GASKET (7) FROM ENGINE BLOCK (6). DISCARD GASKET (7).
- 4. IF NECESSARY, REMOVE BAFFLE (8) FROM PUSH ROD COVER (3).

## **INSTALLATION**

 IF REMOVED, ALIGN BAFFLE (8) ON PUSH ROD COVER (3).

# NOTE

Position adhesive side of gasket (7) towards cover (3) Apply K & W copper coat 1504 sealant to engine block side of gasket (7).



- 2. POSITION PUSH ROD COVER WITH NEW GASKET (7) IN PLACE ON ENGINE BLOCK (6).
- 3. SECURE PUSH ROD COVER (3) TO BLOCK (6)USING SIX CAPSCREWS (4) WITH SIX NEW GROMMET SEALS (5). TORQUE CAPSCREWS TO 216 IN. LB.
- POSITION HOSE (2) ON FITTING AT PUSH ROD COVER (3). SECURE HOSE WITH SPRING CLAMP (1).
- 5. INSTALL FUEL INJECTION PUMP, PARA. 4-4.
- INSTALL FUEL FILTER ASSEMBLY, TM 10-3930-660-20.

# 3-20. OIL PAN - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## Initial Setup

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

# **Equipment Condition**

Engine oil drained, L010-3930-660-12. Negative battery cable disconnected, TM 10-3930-660-20.

#### Materials/Parts

Container, 5 gallon Gasket (3) K&W Copper Coat Sealant (App. B, Item 14) Lint-Free Rags (App. B, Item 38)

#### **REMOVAL**

- PLACE A SUITABLE CONTAINER UNDER OIL PAN (1).
- REMOVE THIRTY-SIX CAPSCREWS (2) AND SPECIAL WASHERS (4).
- 3. REMOVE OIL PAN (1) AND GASKET (3).DISCARD GASKET (3).

## **CLEANING**

See Cleaning Instructions, para. 2-10.

### INSPECTION

See Inspection Instructions, para. 2-11.

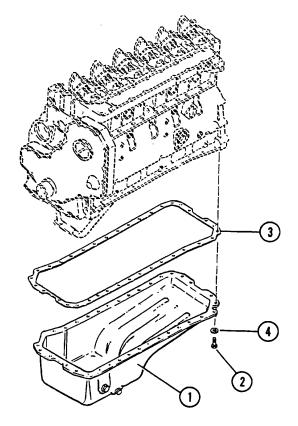
## **INSTALLATION**

 COAT BOTH SIDES OF NEW GASKET (3) WITH SEALANT.

# **NOTE**

Install special washers (4) with concave side towards oil pan.

- 2. INSTALL NEW GASKET (3) AND OIL PAN (1) AND RETAIN WITH THIRTY-SIX SPECIAL WASHERS (4) AND CAPSCREWS (2).
- 3. TIGHTEN CAPSCREWS (2) TO 216 IN. LB.



FILL ENGINE WITH OIL, LO10-3930-66-12.

# 3-21. ENGINE OIL PUMP INLET TUBE - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## Initial Setup

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

## **Equipment Condition**

Engine oil drained, LO10-3930-660-12. Negative battery cable disconnected, TM 10-3930-660-20.

### Materials/Parts

Gasket (2, 8) K&W Copper Coat Sealant (App. B, Item 14) Lint-Free Rags (App. B, Item 38) Oil Pan Gasket (2)

#### **REMOVAL**

- REMOVE OIL PAN (1) AND OIL PAN GASKET (2) BY REMOVING THIRTY-SIX CAPSCREWS (3) AND SPECIAL WASHERS (4). DISCARD GASKET (2).
- REMOVE TWO CAPSCREWS (5) AND ONE CAPSCREW (6) WHICH RETAIN OIL PUMP INLET TUBE (7).
- 3. REMOVE OIL PUMP INLET TUBE (7) AND GASKET (8). DISCARD GASKET (8).

#### **CLEANING**

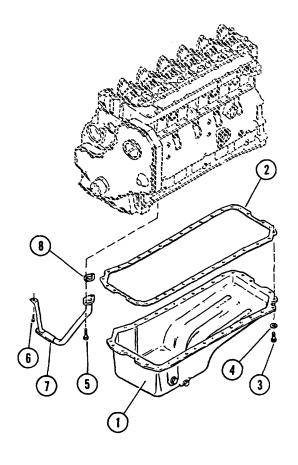
See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **INSTALLATION**

- 1. INSTALL NEW GASKET (8).
- 2. INSTALL OIL PUMP INLET TUBE (7) AND RETAIN WITH TWO CAPSCREWS (5) AND ONE CAPSCREW (6). TIGHTEN CAPSCREWS TO 216 IN. LB.



# 3-21. ENGINE OIL PUMP INLET TUBE - REPLACE (Cont'd)

3. COAT BOTH SIDES OF NEW OIL PAN GASKET (2) WITH SEALANT.

## **NOTE**

Install special washers (4) with concave side towards oil pan.

- 4. INSTALL NEW OIL PAN GASKET (2) AND OIL PAN (1). RETAIN WITH THIRTY-SIX CAPSCREWS (3) AND SPECIAL WASHERS (4). TIGHTEN CAPSCREWS TO 216 IN. LB.
- 5. FILL ENGINE WITH OIL, L010-3930-660-12.
- 6. CONNECT NEGATIVE BATTERY CABLE, TM 10-3930-660-20.

## 3-22. ENGINE OIL PUMP - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

# Initial Setup

## **Tools**

Tool kit, Automotive Mechanics Engine Lubricating Oil (App. B, Item 26) Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

Engine oil drained, L010-3930-660-12. Radiator removed, TM 10-3930-660-20

# Materials/Parts Gasket (12)

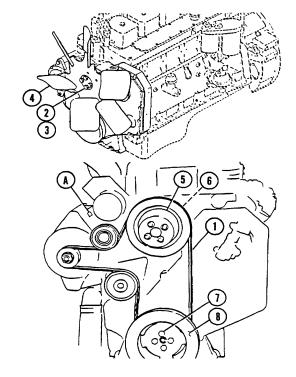
Lint-Free Rags (App. B, Item 38) Seal Kit

# **REMOVAL**

- PLACE A 1/2 INCH SOCKET DRIVER INHOLE (A) AND PULL UP TO RELEASE TENSION ON DRIVE BELT (1).
- 2. REMOVE DRIVE BELT (1).
- 3. REMOVE FOUR CAPSCREWS (2), FOUR FLATWASHERS (3), COOLING FAN (4), FAN PULLEY (5) AND SPACER (6).
- 4. REMOVE FOUR CAPSCREWS (7) AND VIBRATION DAMPER (8).
- 5. REMOVE TACHOMETER DRIVE, TM 10-3930-660-20.

# **NOTE**

Capscrews which retain timing gear cover are of three sizes. Note size and location of capscrews before removal to allow correct location at assembly.



# 3-22. ENGINE OIL PUMP - REPLACE (Cont'd)

- 6. REMOVE TIMING GEAR COVER (9).
  - a. Remove capscrew (10) and belt guide (11).
  - b. Remove eleven capscrews (12) and eight capscrews (13).
  - c. Remove timing gear cover (9) and gasket (14). Discard gasket (14).
- 7. REMOVE FOUR CAPSCREWS (15).
- 8. REMOVE OIL PUMP (16).

# **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

See Inspection Instructions, para. 2-11.

#### INSTALLATION

# **CAUTION**

When installing pump, be sure idler gear pin is installed in the locating bore in the cylinder block. Failure to properly locate oil pump can result in damage to pump and to cylinder block bore.

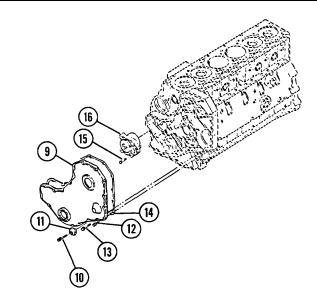
1. LUBRICATE PUMP (16) WITH ENGINE LUBRICATING OIL.

#### NOTE

Filling oil pump with oil prior to installation will help to prime pump at engine start-up.

### **NOTE**

Back plate on pump (16) seats against bottom of cylinder block bore. When pump (16) is correctly installed, flange on pump will <u>not</u> touch cylinder block.



# 3-22. ENGINE OIL PUMP - REPLACE (Cont'd)

- 2. INSTALL OIL PUMP (16) INTO CYLINDER BLOCK BORE AND RETAIN WITH FOUR CAPSCREWS (15).
- 3. TORQUE CAPSCREWS (15) IN OPPOSITE PAIRS TO 216 IN. LB.

# **CAUTION**

Lips of seal in cover (9) and seal surface on crankshaft end must be clean and free of oil. Failure to properly clean sealing surfaces may cause oil to leak at seal.

4. INSTALL TIMING GEAR COVER (9).

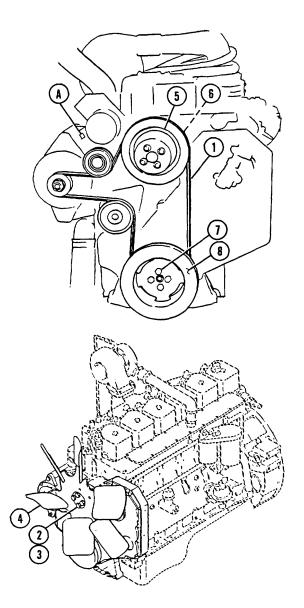
# **CAUTION**

When installing timing gear cover (9), be careful not to damage lips of seal. Failure to protect seal lips during installation of seal over crankshaft end may damage oil seal lips and cause oil leakage.

- a. Install pilot tool from seal kit inside diameter of seal to protect seal lips during gear cover (9) installation.
- b. Install new gasket (14) and timing gear cover (9) onto engine block.
- c. Remove pilot tool from seal bore.
- d. Install eleven capscrews (12) and eight capscrews (13) as noted at disassembly.
- e. Install belt guide (11) and retain with capscrew (10). Tighten capscrews (10, 12, and 13) to 216 in. lb.
- 5. INSTALL TACHOMETER DRIVE, TM 10-3930-660-20.

# 3-22. ENGINE OIL PUMP - REPLACE (Cont'd)

- 6. INSTALL VIBRATION DAMPER (8) AND RETAIN WITH FOUR CAPSCREWS (7). TIGHTEN CAPSCREWS TO 101 LB. FT.
- 7. INSTALL FAN PULLEY (5), SPACER (6), COOLING FAN (4), FOUR FLATWASHERS (3) AND FOUR CAPSCREWS (2).
- 8. PLACE A 1/2 INCH SOCKET DRIVER IN HOLE (A) AND PULL UP TO ALLOW INSTALLATION OF DRIVE BELT (1).
- 9 INSTALL DRIVE BELT (1).
- 10. INSTALL RADIATOR, TM 10-3930-660-20.
- 11. FILL ENGINE WITH OIL, LO10-3930-660-12.



3-129

# 3-23. ENGINE OIL COOLER AND FILTER BASE - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

### **Initial Setup**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

### **Equipment Condition**

Engine oil filter removed, TM 10-3930-660-20. Cooling system drained, TM 10-3930-660-20.

### Materials/Parts

Gasket (9, 11) Lint-Free Rags (App. B, Item 38) Loctite %59241 (App. B, Item 45) O-Ring (2)

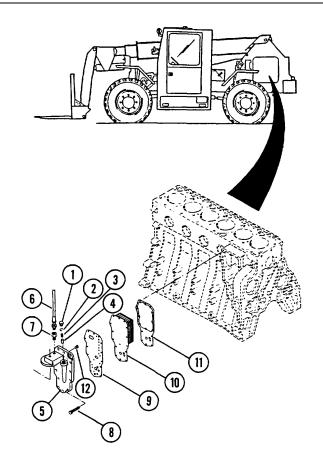
## **REMOVAL**

 IF NECESSARY, REMOVE THREADED PLUG (1), O-RING (2), COMPRESSION SPRING (3) AND PLUNGER (4) FROM OIL FILTER HEAD (5). DISCARD O-RING (2).

## **CAUTION**

Area around turbocharger supply line (6) should be cleaned thoroughly before removal of line (6). Failure to do so could result in contamination of turbocharger lubricant and premature turbocharger failure.

- DISCONNECT TURBOCHARGER SUPPLY LINE
   (6) FROM TOP OF OIL FILTER HEAD (5). IF NECESSARY, REMOVE ADAPTER (7).
- 3. REMOVE FOURTEEN CAPSCREWS (8) WHICH RETAIN THE OIL FILTER HEAD (5).
- 4. REMOVE OIL FILTER HEAD (5), FILTER HEAD GASKET (9), COOLER CORE (10) AND COOLER GASKET (11). DISCARD FILTER HEAD GASKET (9) AND COOLER GASKET (11).



# 3-23. ENGINE OIL COOLER AND FILTER BASE - REPLACE (Cont'd)

 IF NECESSARY, USE A SCREWDRIVER TO REMOVE BYPASS VALVE (12) FROM BACK OF FILTER HEAD (5).

## **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

See Inspection Instructions, para. 2-11.

## **INSTALLATION**

- IF REMOVAL WAS NECESSARY, PROPERLYINSTALL BYPASS VALVE (12) INTO BACK OF FILTER HEAD (5) WITH A MALLET AND SUITABLE DRIVER.
- INSTALL NEW COOLER GASKET (11), COOLER CORE (10), NEW FILTER HEAD GASKET (9) AND FILTER HEAD (5).
- 3. INSTALL FOURTEEN CAPSCREWS (8) AND TORQUE TO 216 IN. LB.
- 4. CONNECT TURBOCHARGER SUPPLY LINE (6) TO TOP OF FILTER HEAD (5).
  - a. If removed, apply Loctite #59241 to threads of adapter (7). Install adapter (7).
  - b. Connect turbocharger supply line (6) to adapter (7).
- 5. IF REMOVED, INSTALL PLUNGER (4), COMPRESSION SPRING (3), NEW O-RING (2), AND PLUG (1). TIGHTEN PLUG TO 60 LB. FT.
- 6. INSTALL OIL FILTER, TM 10-3930-660-20.
- 7. FILL COOLING SYSTEM, TM 10-3930-660-20.

3-131/(3-132 Blank)

## **CHAPTER 4**

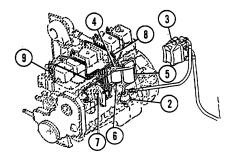
### **FUEL SYSTEM MAINTENANCE**

### Section I. DESCRIPTION AND DATA

## 4-1. GENERAL.

Fuel system maintenance procedures not covered in this section may be found inTM 10-3930-660-20.

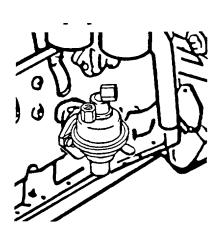
## 4-2. PRINCIPLES OF OPERATION.



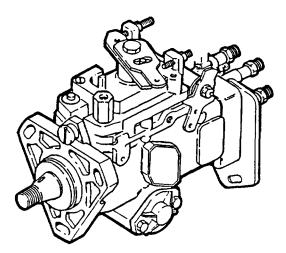
a. <u>Fuel Flow.</u> Fuel is pulled from fuel tank (1) by a cam actuated fuel transfer pump (2). The fuel is drawn through a chassis mounted combination filter/separator (3) and into the fuel transfer pump (2) which supplies low-pressure fuel (3-5psi) to the engine mounted fuel filter head (4). The fuel is pumped through a canister-type combination filter/separator (5) and a canister-type filter (6) and into the fuel injection pump (7). The engine uses a distributor-type fuel pump supplied by Robert Bosch. The distributor pump builds the high injection pressure (3,200 psi) required for combustion, and routes the fuel through individual high-pressure fuel lines (8) to each injector (9).

When the high-pressure fuel reaches the injector, the pressure lifts a needle valve against spring tension in the injector to let the fuel enter the combustion chamber. The fuel injector has very small holes in the tip that change the flow of fuel to a very fine spray that burns easily in the cylinder. Leakage of fuel past the needle valve stem is used for lubrication of the injector. This leakage enters a fuel drain manifold. The fuel drain manifold routes controlled venting (lubrication) from the distributor injection pump and injectors back to the fuel tank.

b. <u>Fuel Transfer Pump</u>. The fuel transfer pump is mechanically driven by a lobe on the camshaft. The fuel transfer pump is located on the left side of the engine.

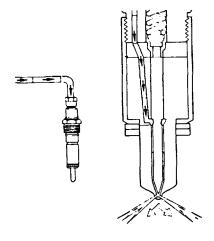


- c. <u>Fuel Injection Pump</u>. The injection pump is a rotary distributor pump. The pump uses a single rotor to develop and distribute the high pressure required for injection. This pump performs the following functions:
  - (1) Produces high fuel pressure required for injection.
  - (2) Meters exact amount of fuel for each injection cycle.
  - (3) Distributes high pressure metered fuel to each cylinder at the precise time.
  - (4) Changes distribution time relative to engine speed.

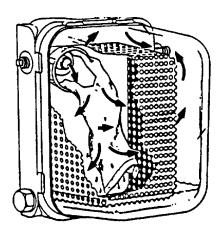


d. <u>Fuel Injectors</u>. The fuel injectors are Robert Bosch, 17mm closed nozzle, hole-type injectors.

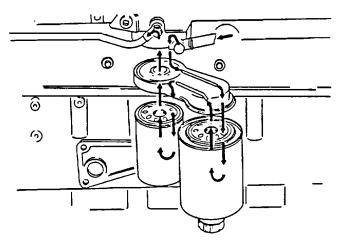
During the injection cycle, high pressure from the injection pump rises to operating (pop) pressure which causes the needle valve in the injector to lift. Fuel is then injected into the cylinder. A shimmed spring is used to force the needle valve closed as the injection pressure drops below the pop pressure to seal off the nozzle after injection.



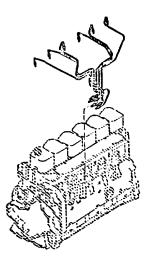
e. <u>Chassis Mounted Fuel-Water Separator/Filter.</u> Filtration and separation of water from the fuel is important for trouble free operation and long life of the fuel system. Some of the clearances between the pump parts are very close. For this reason the parts can easily be damaged by rust formation and contaminants. The chassis mounted separator/filter has two filter elements in a single glass bowl through which the fuel must flow before flowing through the outlet. Water and contaminants settle to the bottom of the sediment bowl and are removed by removing the drain plug.



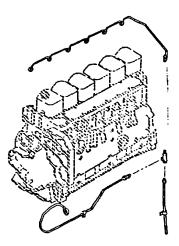
f. <u>Engine Mounted Fuel-Water Separator/Filter Unit.</u> The engine mounted fuel-water separator/filter unit has two replaceable elements. One element of the filter has a valve which can be opened regularly to drain the collected water. The dual canister configuration provides additional filtering capacity. The fuel flows through the adaptor to a large combination fuel-water separator/filter and back to the fuel filter for final filtering.



g. <u>High Pressure Fuel Lines</u>. The high pressure fuel lines are designed and manufactured to deliver fuel at injection pressure to the injectors. The high pressure pulses will cause the lines to expand and contract during the injection cycle. The high pressure fuel lines are clamped and routed so that they do not contact each other or any other components.



h. <u>Fuel Drain Manifold</u>. The fuel system is designed to use fuel to cool and lubricate the injection pump and injectors. Fuel is continually vented from the injection pump and a small amount of fuel leaks by the injector needle valve stem during injection. This fuel is returned to the supply tank by the fuel drain manifold.



Section II. FUEL SYSTEM MAINTENANCE PROCEDURES.

### **FUEL SYSTEM MAINTENANCE TASK SUMMARY**

TASK		PAGE
PARA.	PROCEDURES	NO.
4-3	Fuel Injector - Test/Replace	4-5
4-4	Fuel Injection Pump - Replace	4-9
4-5	Fuel Shutoff Valve - Replace	4-14
4-6	Turbocharger Assembly - Repair	4-16
4-7	Fuel/Hydraulic Tank - Replace/Repair	4-24

#### 4-3. FUEL INJECTOR - TEST/REPLACE

#### This task covers:

- a. Removal
- b. Cleaning and Inspection
- c. Testing
- d. Installation

# **Initial Setup**

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Tool Kit, Machinist: Post, Camp and Station

Test Set, Diesel Injector

### **Equipment Condition**

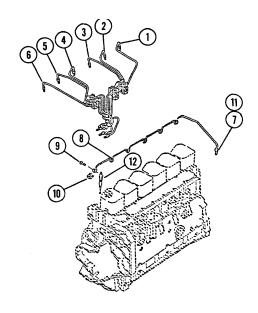
Engine shut off and cooled to near ambient temperature.
Negative battery cable disconnected, TM10-3930-660-20.

# Materials/Parts

Anti-Seize Compound (App. B, Item 3) Banjo Connector Seal (10) Copper Injector Seals (13) Diesel Fuel Oil (App. B, Item 17) Grommet Seal (11) Rust Penetrating Solvent (App. B, Item 51)

## **REMOVAL**

- SHUT OFF ENGINE AND ALLOW ENGINE TO COOL TO NEAR AMBIENT TEMPERATURE.
- 2. DISCONNECT FUEL SUPPLY TUBES (1-6) FROM INJECTORS. POSITION LINES CLEAR OF INJECTORS WITHOUT PUTTING KINKS IN LINES.
- 3. LOOSEN NUT (7) TO REMOVE FUEL MANIFOLD (8) FROM TEE FITTING.
- 4. REMOVE SIX BANJO CONNECTOR SCREWS (9) AND FUEL MANIFOLD (8).
- 5. REMOVE AND DISCARD SIX BANJO CONNECTOR SEALS (10) AND GROMMET SEAL (11).
- CLEAN AREA OF CYLINDER HEAD AROUND INJECTORS (12) WITH A SOFT BRUSH AND LOW PRESSURE COMPRESSED AIR.



# 4-3. FUEL INJECTOR - TEST/REPLACE (Cont'd)

### **CAUTION**

If rust has formed on injector hold-down nut, injector can turn in its bore as hold-down nut is loosened. Dissolve and loosen rust as instructed in STEP 6. Failure to follow instructions in STEP 6 can result in severe damage to cylinder head.

- 7. IF NECESSARY, APPLY RUST PENETRATING SOLVENT TO INJECTOR HOLD-DOWN NUT AND ALLOW SOLVENT TO REMAIN FOR A MINIMUM OF THREE MINUTES. THEN TAP AGAINST INJECTOR BODY WITH HAMMER AND DRIFT PIN TO LOOSEN RUST.
- 8. HOLD INJECTOR BODY WITH AN ADJUSTABLE WRENCH WHILE TURNING HOLD-DOWN NUT OUT OF INJECTOR BORE WITH A BOX END WRENCH.
- 9. REMOVE INJECTOR (12). REMOVE AND DISCARD COPPER INJECTOR SEAL (13).

#### **CLEANING**

RINSE NOZZLE WITH SOLVENT, PARA. 2-10.

## **INSPECTION**

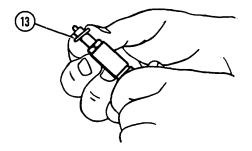
INSPECT NEEDLE TIP FOR ROUGHNESS OR EROSION. NOTE THAT ROUGH MACHINED APPEARANCE IS NORMAL FOR PRESSURE SHOULDER.

## **TESTING**

1. OPENING PRESSURE TEST.

## **WARNING**

Keep clear of test spray from nozzle. Fluid at test pressures can penetrate skin, causing infection and possible death.



# 4-3. FUEL INJECTOR - TEST/REPLACE (Cont'd)

- a. Connect injector to fuel injector test set.
- b. Open valve and operate pump lever at a rate of one stroke per second while observing test pressure gauge.
- c. Spray must begin at a pressure of 3553+73 psi.
- d. If spray does not begin within pressure range specified in STEP c, change thickness of shims (20). Adding shims will increase opening pressure. Remove shims to decrease opening pressure.
- e. Check for well atomized spray pattern.

#### 2. LEAKAGE TEST.

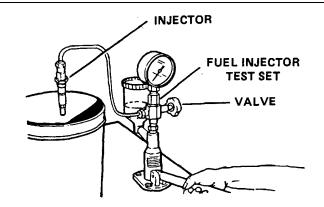
- Use same test setup as for opening pressure test (STEP 1, above).
- b. Open valve on test set.
- c. Operate pump lever as necessary to hold pressure at a level about 290 psi below opening pressure noted in STEP 1c, above.
- d. No drops must fall from nozzle tip for a period of 10 seconds, while maintaining pressure specified in STEP 2c, above. If drops do appear within 10 seconds, replace injector.

### 3. CHATTER TEST.

a. Use same test setup as for opening pressure test (STEP 1, above).

# **NOTE**

Do not evaluate used nozzles at lower pumping rates. A used nozzle is serviceable if it passes the leakage test, chatters audibly at higher pumping rates and uniformly atomizes fuel.



# 4-3. FUEL INJECTOR - TEST/REPLACE (Cont'd)

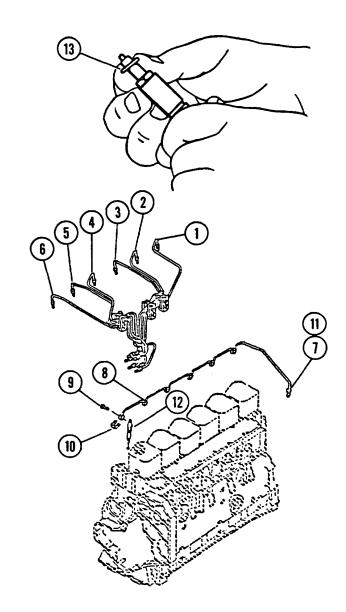
 b. Operate pump lever at a rate that causes nozzle to chatter softly while discharging fuel in a broad and finely atomized pattern. If conditions of prior note are not met, replace nozzle.

#### **INSTALLATION**

- APPLY ANTI-SEIZE COMPOUND TO HOLD-DOWN NUT THREADS.
- 2. INSTALL FUEL INJECTORS (12).
  - a. Install one new copper injector seal (13) on each nozzle.
  - b. Install injector, (12) using care to align button on injector nozzle holder with notch in cylinder head bore.
  - c. Torque injector (12) nut to 44 lb. ft
  - d. Install new banjo connector seal (10) in gap between nozzle holder and injector nut.
  - e. Install fuel manifold (8) and new seals (11), and secure to injectors with screws (9). Tighten nuts (7) on manifold (8).
  - f. Loosely connect fuel high pressure tubes (1-6) to fuel injectors. Leave connections loose until bleeding procedure (STEP 3, below) is completed.
- 3. CONNECT NEGATIVE BATTERY CABLE, M10-3930-660-20.
- 4. BLEED FUEL SYSTEM.

### **WARNING**

To bleed fuel system, engine must be placed in a run condition. Because engine may start during bleeding procedure, all necessary safety precautions must be followed. See TM10-3930-660-10 (unit operation manual).



- a. Briefly crank engine to allow air entrapped in high fuel pressure lines to escape around fittings on fuel injectors.
- b. Tighten fittings to 216 in. lb.

### 4-4. FUEL INJECTION PUMP - REPLACE

### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

## **Tools**

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Tool Kit, General Mechanics

### **Equipment Condition**

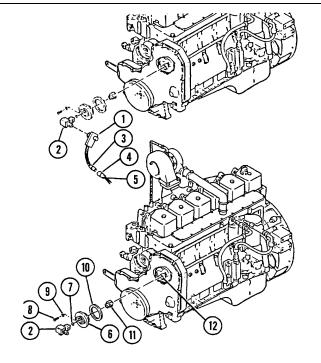
Negative battery cable disconnected, TM10-3930-660-20. Vibration damper removed, para. 3-11.

# Materials/Parts

Gasket (7, 29) Lockwasher (26) Seal (10)

#### **REMOVAL**

- 1. REMOVE STE/ICE PULSE TACHOMETER (1) AND DRIVE (2).
  - a. Separate male connector (3) from female connector (4) on wiring harness (5).
  - b. Loosen nut on tachometer (1) and remove tachometer from drive (2).
  - c. Remove tachometer drive (2) from cover (6) by removing two screws (8), and flatwashers (9).
  - d. Remove and discard gasket (7).
  - e. Remove cover (6) from front cover by turning cover (6) counterclockwise.
  - f. Remove and discard seal (10).
  - g. Remove hub (11) from injection pump shaft (12).

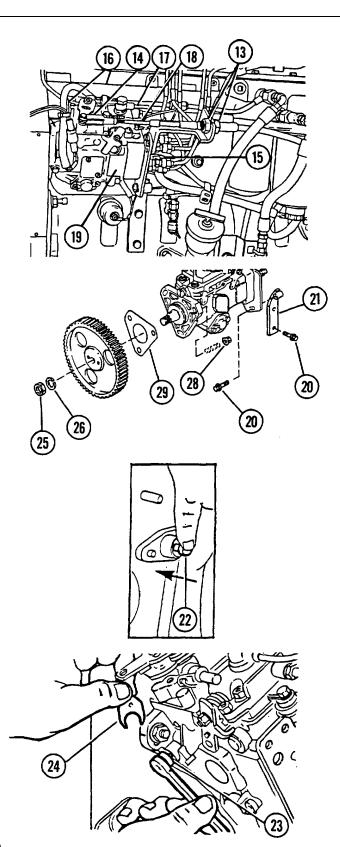


- 2. REMOVE FUEL INJECTION PUMP (18).
  - a. Loosen nuts (13).
  - b. Disconnect accelerator cable (14) from fuel injection pump control lever.
  - Disconnect six high fuel pressure lines (15), fuel supply line (16), fuel drain line (17) and fuel shutoff valve wiring lead (18) from fuel injection pump (19).
  - d. Remove three capscrews (20) and brace (21).

### **NOTE**

Steps e through g must be performed in order to time fuel injection pump to engine when pump is installed.

- e. Locate TDC for cylinder number 1 by slowly turning engine crankshaft while pushing in on TDC pin (22). Pin will fit into a hole on the camshaft gear when engine is at TDC for No. 1 cylinder.
- f. Disengage TDC pin (22) immediately after locating TDC for cylinder number 1 to prevent damage to pin.
- g. Loosen screw (23) and remove timing lock plate (24). Tighten screw (23) against fuel injection pump shaft. Secure timing lock plate (24) to fuel injection pump with a wire to prevent its loss.
- h. Remove front cover, para. 3-19, steps 4-7.



- Hold crankshaft to prevent locked fuel injection pump from turning while loosening nut (25) in STEP j, below.
- Use care not to drop nut (25) or lockwasher (26) behind front cover. Remove nut (25) and lockwasher (26). Discard lockwasher (26).
- k. Remove drive gear (27) from fuel injection pump shaft, using puller (A) as shown.
- Make sure scribe marks (B) are present and visible on injection pump and timing gear housing.
- m. Remove three nuts (28) and carefully remove fuel injection pump and mounting gasket (29). Do not allow key (30) to drop from pump shaft into timing gear housing.
- n. Discard gasket (29) and clean gasket residue from surface on timing gear housing.

#### **CLEANING**

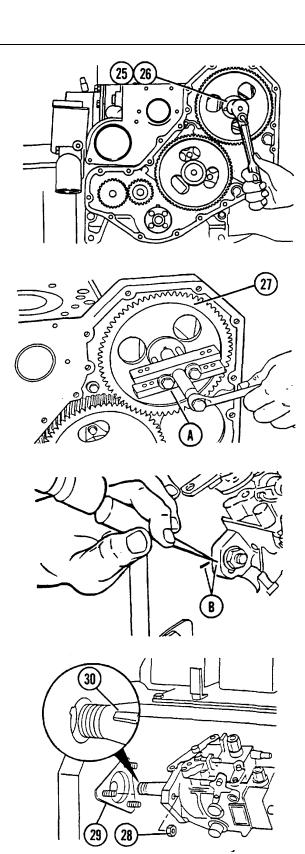
See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

## **INSTALLATION**

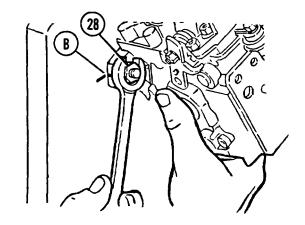
- 1. PUSH IN TDC PIN (22) TO VERIFY CYLINDER NUMBER 1 IS AT TDC. IF NECESSARY, TURN ENGINE CRANKSHAFT UNTIL TDC PIN CAN BE PUSHED IN FULLY.
- 2. INSTALL FUEL INJECTION PUMP.
  - a. Place new gasket (29) on pump mounting studs.

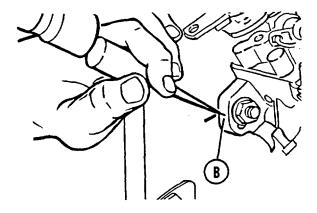


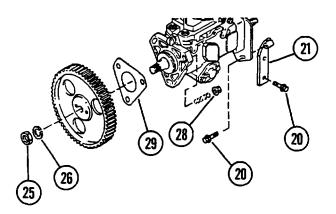
### **NOTE**

New and reconditioned fuel injection pumps come with drive shafts locked at an angle which aligns shaft key with keyway in drive gear. Screw (23) is tightened against shaft to lock shaft. Do not loosen screw (23) until instructed to do so in STEP h, below.

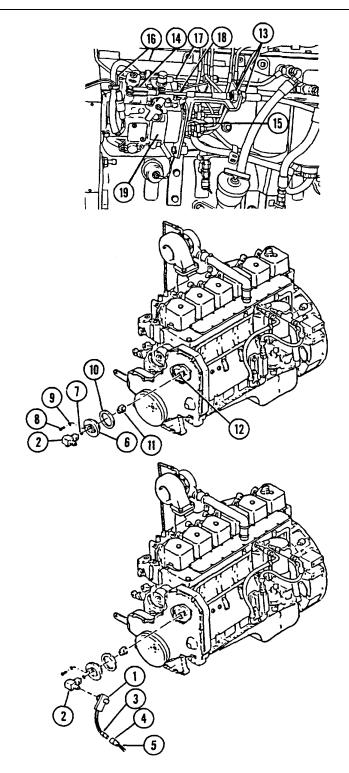
- b. Position fuel injection pump (19) on mounting studs, using care to prevent key (30) from dropping into timing gear housing while aligning key (30) with keyway in gear.
- c. Install three nuts (28) finger tight on pump mounting studs. Pump must be free to move until timing has been set.
- d. Install new lockwasher (26) and nut (25).
- e. If original pump is being installed, rotate pump to align scribe marks (B). Then tighten three nuts (28) to 18 lb. ft.
- f. If installing a new or rebuilt pump without scribe mark, rotate pump against direction of drive rotation to take up backlash in gearing and tighten nuts (28) to a torque of 18 lb. ft. Then place a scribe mark (B) on pump flange using a hammer and small chisel.
- g. Loosen screw (23) and insert timing lock plate (24) under head of screw (23). Tighten screw (23) to a torque of 120 lb. in.
- h. Disengage TDC pin (22).
- i. Tighten nut (25) to a torque of 48 lb. ft.
- j. Install front cover, para. 3-19, steps 4-7.







- k. Install brace (21) and three capscrews (20). Leave capscrews (20) finger tight until certain that brace (21) is properly positioned.
- In order, tighten two brace-toblock capscrews (20) and then one brace-to-pump flange capscrew to a torque of 216 in. lb.
- m. Tighten nuts (13).
- 3. CONNECT ELECTRICAL LEAD (18) TO FUEL SHUTOFF VALVE, CONNECT FUEL DRAIN LINE (17), CONNECT FUEL SUPPLY LINE (16) AND CONNECT SIX HIGH FUEL PRESSURE LINES (15) TO FUEL INJECTION PUMP (19).
- INSTALL STE/ICE PULSE TACHOMETER AND DRIVE.
  - a. Install hub (11) on shaft (12).
  - b. Install new seal (10) and cover (6).
  - c. Install new gasket (7), drive (2), two screws (8), and two flatwashers (9).
  - d. Install tachometer (1) on drive(2) and tighten nut.
  - e. Connect male connector (3) to female connector (4) on wiring harness (5).
- 5. CONNECT BATTERIES, TM10-3930-660-20.
- 6. BLEED FUEL LINES, PARA. 4-3.



### 4-5. FUEL SHUTOFF VALVE - REPLACE

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## **Initial Setup**

**Tools** 

Tool Kit, Auto Mechanics

**Equipment Condition** 

Vehicle parked on level surface.

Engine shut off.

Negative battery cable disconnected,

TM10-3930-660-20.

Materials/Parts Lockwasher (7) O-ring (5)

## **REMOVAL**

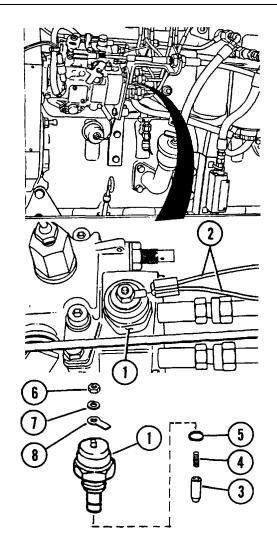
- 1. CLEAN FUEL SHUTOFF VALVE (1) AND SURROUNDING AREA OF PUMP TO PREVENT ENTRY OF CONTAMINANTS INTO VALVE.
- 2. REMOVE FUEL SHUTOFF VALVE (1).
  - a. Disconnect electrical wires (2) from shutoff valve (1).
  - b. Remove shutoff valve (1), using care not to drop plunger (3) and spring (4).
  - c. Remove O-ring (5), nut (6), lockwasher (7) and spade terminal (8). Discard O-ring (5) and lockwasher (7).

## **NOTE**

Discard entire shutoff valve assembly, which includes plunger (3) and spring (4), if shutoff valve is defective.

## **INSTALLATION**

 INSTALL NEW O-RING (5), SPADE TERMINAL (8), NEW LOCKWASHER (7) AND NUT (6) ON SHUTOFF VALVE (1).



# 4-5. FUEL SHUTOFF VALVE - REPLACE (Cont'd)

- 2. PLACE PLUNGER (3) AND SPRING (4) IN POSITION IN SHUTOFF VALVE BORE.
- INSTALL SHUTOFF VALVE (1), MAKING CERTAIN THAT PLUNGER (3) AND SPRING (4) REMAIN PROPERLY ASSEMBLED TO VALVE (1) DURING INSTALLATION.
- 4. CONNECT ELECTRICAL LEAD (2) TO SHUTOFF VALVE (1).
- 5. CONNECT NEGATIVE BATTERY CABLE, TM10-3930-660-20.

### 4-6. TURBOCHARGER ASSEMBLY - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

### **Initial Setup**

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

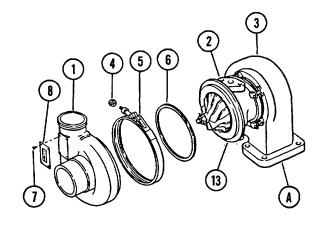
Equipment Condition Turbocharger removed, TM10-3930-660-20. Capscrews (18)
Crocus Cloth (App. B, Item 4)
Engine Lubricating Oil (App. B, Item 26)
Locknut (9)
Lock Plates (12,22)
Loctite #767-64 (App. B, Item 46
Medium Grit Emery Cloth (App. B Item 5)
Rectangular Ring Seal (6)
Retaining Rings (27, 29)
Seal (14, 16, 26)

Thrust Bearing (19)

Materials/Parts

#### **DISASSEMBLY**

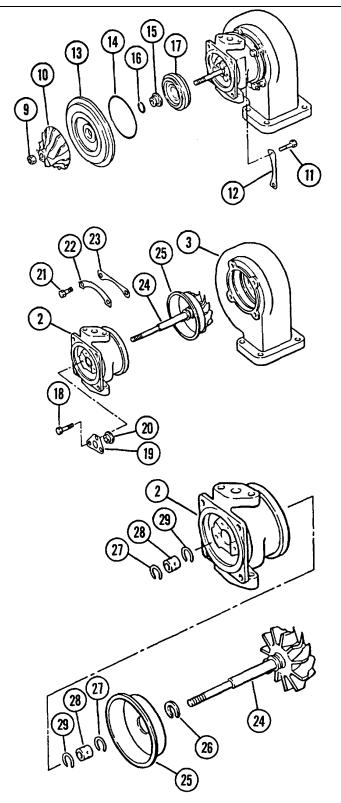
- MARK COMPRESSOR HOUSING (1), BEARING HOUSING (2), TURBINE HOUSING (3), AND DIFFUSER (13), FOR CORRECT PART ORIENTATION AT ASSEMBLY.
- 2. PLACE TURBOCHARGER IN A VISE AND CLAMP BY THE TURBINE HOUSING INLET FLANGE (A). PLACE SOFT METAL COVERS OVER VISE JAWS TO PREVENT DAMAGE TO TURBINE HOUSING (3).
- 3. LOOSEN NUT (4) ON V-BAND CLAMP (5).
- REMOVE COMPRESSOR HOUSING (1), V-BAND CLAMP (5) AND RECTANGULAR RING SEAL (6). DISCARD RECTANGULAR RING SEAL (6).
- 5. IF NECESSARY, REMOVE DATAPLATE (8).
  - a. Remove four drivescrews (7).
  - b. Remove dataplate (8).



#### **NOTE**

Threads on locknut (9) are left-handed. Turn locknut (9) clockwise to remove.

- 6. REMOVE LOCKNUT (9), AND COMPRESSOR IMPELLER (10). DISCARD LOCKNUT (9).
- 7. REMOVE FOUR CAPSCREWS (11) AND TWO LOCK PLATES (12). DISCARD LOCK PLATES (12).
- 8. REMOVE DIFFUSER (13) AND DIFFUSER SEAL (14).DISCARD SEAL (14).
- 9. REMOVE OIL SLINGER (15) AND SPLIT RING SEAL (16) AS AN ASSEMBLY FROM THE DIFFUSER (13).
- REMOVE SPLIT RING SEAL (16) FROM OIL SLINGER (15).DISCARD SPLIT RING SEAL (16).
- 11. REMOVE OIL BAFFLE (17).
- 12. REMOVE THREE CAPSCREWS (18) AND THRUST BEARING (19). DISCARD THRUST BEARING (19) AND CAPSCREWS (18).
- 13. REMOVE THRUST COLLAR (20).
- 14. REMOVE FOUR CAPSCREWS (21), TWO LOCK PLATES (22) AND CLAMPING PLATE (23). DISCARD LOCK PLATES (22) AND CAPSCREWS (21).
- 15. REMOVE BEARING HOUSING (2) FROM TURBINE HOUSING (3).
- 16. REMOVE SHAFT AND WHEEL (24) AND HEAT SHIELD (25) FROM BEARING HOUSING (2) AS AN ASSEMBLY.
- 17. REMOVE HEAT SHIELD (25) FROM SHAFT AND WHEEL (24).
- 18. REMOVE SPLIT RING SEAL (26) FROM SHAFT AND WHEEL (24). DISCARD SPLIT RING SEAL (26).



- REMOVE TWO OUTER RETAINING RINGS
   (27) FROM BORE OF BEARING HOUSING
   (2). DISCARD RETAINING RINGS (27).
- 20. REMOVE TWO BEARINGS (28). DISCARD BEARINGS (28).
- 21. REMOVE TWO INNER RETAINING RINGS (29) FROM BORE OF BEARING HOUSING (2). DISCARD RETAINING RINGS (29).

### **CLEANING**

# **CAUTION**

Do not use a wire brush on the compressor wheel. Use of a wire brush on compressor wheel may cause premature component failure.

- 1. USE A SCRAPER AND MEDIUM GRIT EMERY CLOTH TO REMOVE CARBON BUILDUP FROM TURBINE HOUSING (3).
- 2. POLISH BEARING SURFACES ON SHAFT (24) WITH CROCUS CLOTH.
- 3. FOR GENERAL CLEANING INSTRUCTIONS, SEE CLEANING INSTRUCTIONS, PARA. 2-10.

### **INSPECTION**

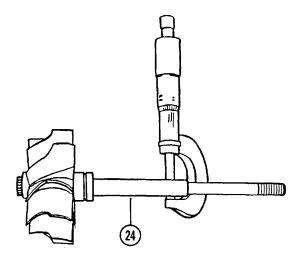
- 1. MEASURE SHAFT (24) BEARING DIAMETER. SHAFT BEARING SURFACE MINIMUM DIAMETER IS 0.432 INCH.
- 2. FOR GENERAL INSPECTION INSTRUCTIONS, SEE INSPECTION INSTRUCTIONS, PARA. 2-11.

## **ASSEMBLY**

# NOTE

Balance marks on shaft (24), thrust collar (20) and impeller (10) must be aligned to make sure rotating parts of turbocharger are properly balanced.

 APPLY ENGINE OIL TO GROOVE (B) ON SHAFT (24).



- 2. INSTALL NEW SPLIT RING SEAL (26) ONTO SHAFT (24) GROOVE (B).
- 3. INSTALL HEAT SHIELD (25) ONTO SHAFT (24).
- 4. CLAMP A SOCKET IN A VISE AND PLACE SHAFT AND WHEEL (24) NUT END IN SOCKET.

#### NOTE

Beveled face of retaining rings (29) must face bearings (28).

- 5. INSTALL NEW INNER RETAINING RINGS (29) INTO BEARING HOUSING (2).
- 6. APPLY ENGINE OIL TO NEW BEARINGS (28).
- 7. INSTALL NEW BEARINGS (28) INTO BEARING HOUSING (2).

## **NOTE**

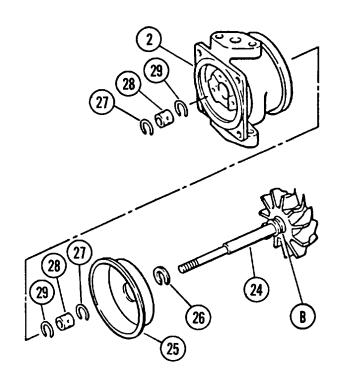
Beveled face of retaining rings (27) must face bearings (28).

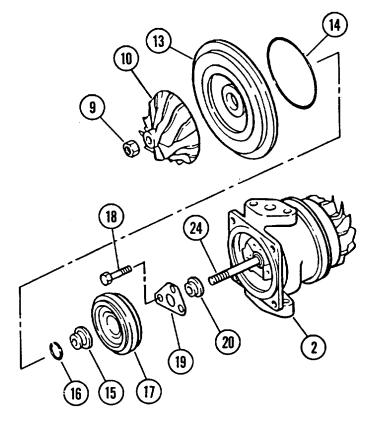
- 8. INSTALL NEW OUTER RETAINING RINGS (27) INTO BEARING HOUSING (2).
- 9. INSTALL BEARING HOUSING (2) ONTO SHAFT AND WHEEL (24).ROTATE HOUSING (2) WHILE PRESSING ONTO SHAFT (24) TO SEAT BEARINGS (28).

### **CAUTION**

When installing thrust collar (20), be sure balance mark on collar (20) is aligned with shaft (24) balance mark. Mark top surface of thrust collar (20) so alignment can be verified after installing thrust bearing (19). Failure to align balance marks could cause premature component failure.

10. INSTALL THRUST COLLAR (20) ONTO SHAFT AND WHEEL (24).





- 11. APPLY ENGINE OIL TO NEW THRUST BEARING (19).
- 12. INSTALL NEW THRUST BEARING (19) AND SECURE WITH THREE NEW CAPSCREWS (18).TORQUE CAPSCREWS TO 40 LB. IN.
- 13. INSTALL OIL BAFFLE (17) ONTO SHAFT (24).
- 14. INSTALL NEW SPLIT RING OIL SEAL (16) ONTO OIL SLINGER (15).
- 15. MARK TOP SURFACE OF OIL SLINGER (15) IN LINE WITH BALANCE MARK.
- 16. APPLY ENGINE OIL TO OUTSIDE OF OIL SLINGER (15).
- 17. INSTALL OIL SLINGER (15) AND NEW SPLIT RING OIL SEAL (16) INTO DIFFUSER (13). INSTALL NEW RING SEAL (14) INTO DIFFUSER (13).
- 19. ALIGN BALANCE MARKS ON SHAFT (24) AND OIL SLINGER (15).
- 20. INSTALL OIL SLINGER (15) AND DIFFUSER (13), AS AN ASSEMBLY, ONTO SHAFT (24).

### **CAUTION**

When installing impeller (10), be sure to align balance marks on shaft (24) and impeller (10). Failure to do so could cause premature component failure.

## **CAUTION**

Do not move bearing housing (2) when installing impeller (10). Moving bearing housing (2) during impeller (10) installation will cause improper balance and premature component failure.

21. INSTALL IMPELLER (10) ONTO SHAFT (24).

## CAUTION

Do not allow impeller (10) to turn when installing locknut (9). Failure to prevent impeller from turning will result in improper balance and premature component failure.

### **NOTE**

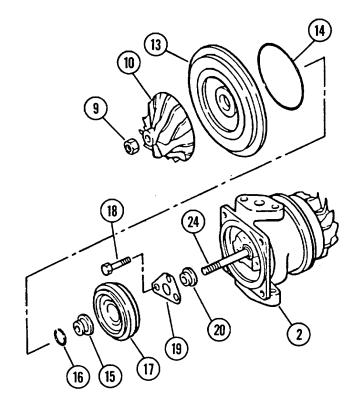
Locknut (9) has left-hand threads, be sure to turn locknut (9) counter-clockwise when installing.

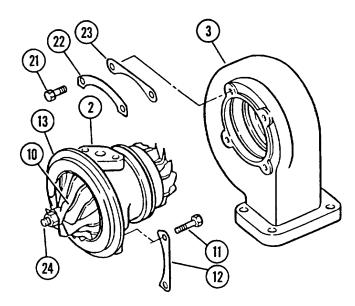
- 22. INSTALL NEW LOCKNUT (9) ONTO SHAFT. TORQUE LOCKNUT (9) TO 120 LB. IN.
- 23. INSTALL BEARING HOUSING (2), IMPELLER (10) AND SHAFT (24) INTO TURBINE HOUSING (3) AS AN ASSEMBLY.
- 24. ALIGN MATCH MARKS ON BEARING HOUSING (2) AND TURBINE HOUSING (3) THAT WERE MADE AT DISASSEMBLY.

## **NOTE**

When installing new capscrews (21), apply Loctite #767-64 to capscrew (21) threads.

- 25. APPLY LOCTITE #767-64 TO NEW CAPSCREW (21) THREADS.
- 26. INSTALL TWO NEW LOCK PLATES (22), ONE CLAMPING PLATE (23), AND FOUR NEW CAPSCREWS (21) INTO TURBINE HOUSING.
- 27. TORQUE CAPSCREWS (21) TO 100 LB. IN.
- 28. BEND LOCK PLATE (22) TABS UP TO SECURE CAPSCREWS (21).
- 29. INSTALL TWO NEW LOCK PLATES (12) AND FOUR CAPSCREWS (11) THROUGH BEARING HOUSING (2) AND INTO DIFFUSER (13).
- 30. TORQUE CAPSCREWS (11) TO 50 LB. IN.

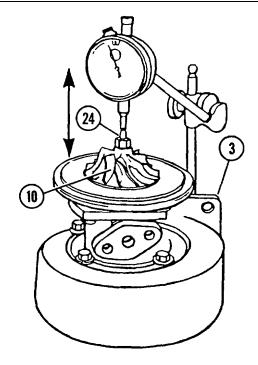


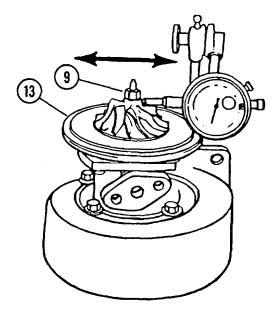


## **CAUTION**

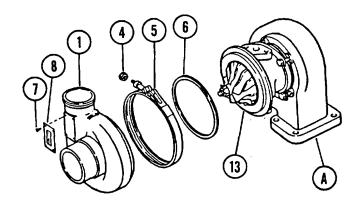
Be sure scribe marks on diffuser (13) bearing housing (2) and turbine housing (3) are properly aligned during assembly. Failure to properly align components could result in premature component failure.

- 31. BEND LOCK PLATE (12) TABS UP TO SECURE CAPSCREWS (11).
- 32. MEASURE SHAFT END PLAY.
  - a. Attach a dial indicator to the turbine housing (3). Adjust dial indicator so that plunger is against shaft (24) end.
  - b. Set dial indicator to zero.
  - c. Move shaft (24) and impeller (10) assembly back and forth and read end play on dial indicator. If end play is less than 0.001 inch, or greater than 0.003 inch, disassemble turbocharger, STEPS 1-19, and check for problem. Replace defective parts and assemble, STEPS 1-32.
- 33. MEASURE RADIAL CLEARANCE OF SHAFT (24).
  - a. Attach a dial indicator to turbine housing. Adjust dial indicator plunger so that plunger is against end of impeller (13) between fins and jam nut (9).
  - b. Set dial indicator to zero.





- c. Move end of impeller (13) left and right and read radial clearance on dial indicator. If radial clearance is less than 0.012 inch or greater than 0.018 inch, disassemble turbocharger, STEPS 1-19, and check for problem. Replace defective parts and assemble, STEPS 1-33.
- 34. IF REMOVAL WAS NECESSARY, INSTALL DATAPLATE (8) AND SECURE WITH FOUR DRIVESCREWS (7).
- 35. INSTALL RING SEAL (6) ONTO TURBOCHARGER DIFFUSER (13).
- 36. APPLY LOCTITE #767-64 TO V-BAND CLAMP (5) BOLT THREADS.
- 37. INSTALL COMPRESSOR HOUSING (1) AND V-BAND CLAMP ONTO DIFFUSER (13). TIGHTEN NUT (4) TO 120 LB. IN.
- 38. TAP CLAMP (5) IN FOUR PLACES, 900 APART TO SEAT CLAMP.
- 39. TIGHTEN NUT (4) TO 120 LB. IN. AGAIN.



### 4-7. FUEL/HYDRAULIC TANK - REPLACB/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# Initial Setup

### Tools

Tool Kit, Auto Mechanics

Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power

Tool Kit, Body and Fender Repair

Lifting Device, Capacity 500 lb.

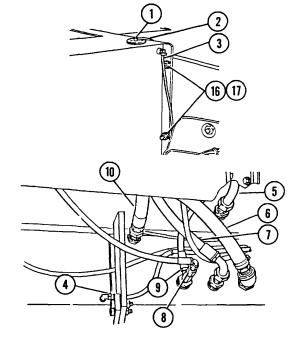
**Equipment Condition** 

Fuel and hydraulic tanks drained, TM10-3939-660-10. Negative battery cable removed, TM10-3930-660-20. Materials/Parts

Caps Gaskets (21, 28, 32, and37) Lockwashers (13, 17, 26, 35) Tags (App. B, Item 52)

## **REMOVAL**

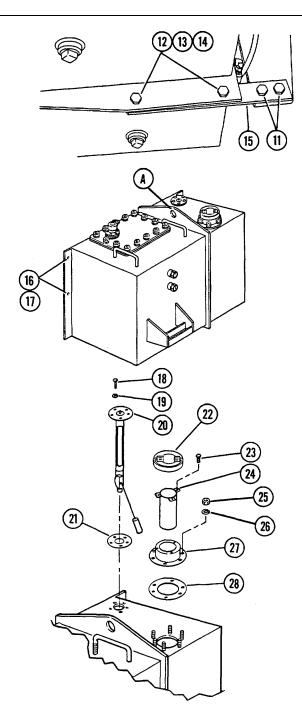
- 1. REMOVE NUT (1) DISCONNECT ELECTRICAL LEAD (2) FROM FUEL LEVEL SENDER.
- 2. DISCONNECT TWO FUEL LINES (3 AND 4) AND SIX HYDRAULIC LINES (5 THROUGH 10). TAG EACH LINE AS IT IS DISCONNECTED TO INSURE PROPER CONNECTIONS, AND PLUG AND CAP ALL OPENINGS.



- 3. LOOSEN TWO NUTS (11).
- 4. REMOVE TWO NUTS (12), LOCKWASHERS (13) AND CAPSCREWS (14) ATTACHING TANK ASSEMBLY TO SUPPORT BAR (15). DISCARD LOCKWASHERS (13).
- 5. CONNECT A HOIST OR OTHER SUITABLE LIFTING DEVICE TO LIFTING EYE (A) ON TOP OF TANK.
- 6. TAKE UP SLACK IN LIFTING DEVICE AND THEN REMOVE FOUR NUTS (16) AND LOCKWASHERS (17). DISCARD LOCKWASHERS (17).
- 7. LIFT TANK ASSEMBLY AWAY FROM VEHICLE FRAME.

#### **DISASSEMBLY**

- REMOVE FUEL LEVEL SENDER.
  - a. Remove five screws (18) and lockwashers (19). Discard lockwashers (19).
  - b. Remove fuel sender unit (20) and gasket (21). Discard gasket (21).
- 2. REMOVE FUEL FILLER ASSEMBLY.
  - a. Remove filler cap (22).
  - b. Remove three screws (23) and strainer (24).
  - c. Remove six nuts (25) and lockwashers (26). Discard lockwashers (26).
  - d. Remove filler neck (27) and gasket (28). Discard gasket (28).



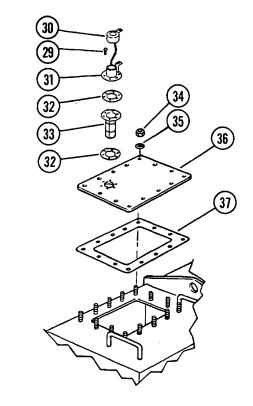
- REMOVE HYDRAULIC TANK FILLER ASSEMBLY AND TOP COVER.
  - a. Remove six screws (29).
  - b. Remove filler cap/breather (30).
  - c. Remove filler neck (31), two gaskets (32) and strainer (33). Discard gaskets (32).
  - d. Remove 14 nuts (34) and lockwashers (35) to remove cover (36) and gasket (37). Discard gasket (37). Discard lockwasher (35).
- 4. REMOVE STRAINERS (38 AND 39), NIPPLES (38 AND 41), DRAIN PLUGS (42 AND 43) AND TWO SIGHT GAUGES (44) FROM TANK (45) AS REQUIRED FOR REPLACEMENT.

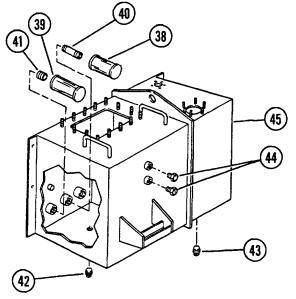
### **CLEANING**

SEE CLEANING INSTRUCTIONS, PARA. 2-10.

## **INSPECTION**

- INSPECT EXTERIOR SURFACES, HARDWARE AND THREADED FITTINGS FOR CORROSION OR DAMAGE, PARA. 2-11. REPAIR BREAKS IN TANK WALLS, IF POSSIBLE, BY WELDING (SEE TM9-237).
- 2. INSPECT FUEL AND HYDRAULIC OIL STRAINERS FOR DAMAGE OR SIGNS OF CLOGGING. REPLACE STRAINERS AS REQUIRED.



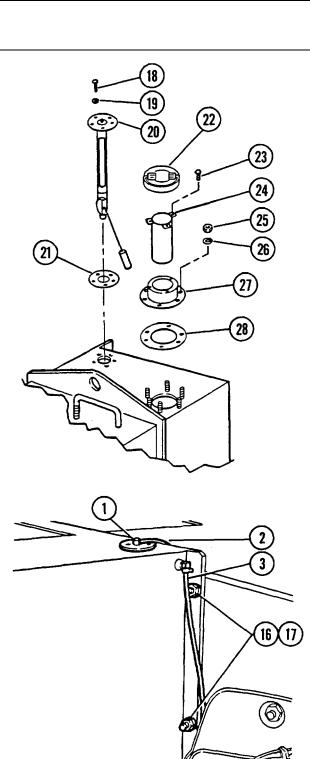


#### **ASSEMBLY**

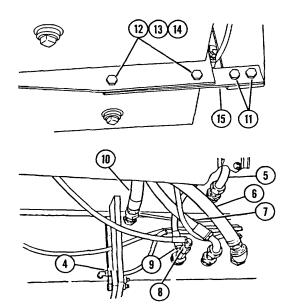
- 1. INSTALL ITEMS (38 THROUGH 44) AS APPLICABLE.
- 2. INSTALL HYDRAULIC FILLER ASSEMBLY AND TOP COVER.
  - a. Use new gasket (37) and new lockwashers (35).
  - b. Tighten 14 nuts (34) in even increments to final torque, to prevent distortion of cover (36).
  - c. If items (31, 32 and 33) were removed, install new gaskets (32).
  - d. Attach chain of filler cap/breather using one screw (29).
- 3. INSTALL FUEL TANK FILLER COMPONENTS.
  - a. Use new gasket (28).
  - b. Tighten six nuts (25) in even increments to final torque.
- 4. INSTALL NEW GASKET (21) AND FUEL LEVEL SENDER (20). SECURE WITH FIVE SCREWS (18) AND NEW LOCKWASHERS (19).

## **INSTALLATION**

- 1. LIFT TANK ASSEMBLY INTO PLACE ON VEHICLE AND ENGAGE MOUNTING STUDS.
- 2. INSTALL FOUR NEW LOCKWASHERS (17) AND NUTS (16). DISCONNECT HOISTING SLING.



- 3. INSTALL *TWO* CAPSCREWS (12), NUTS (14) AND NEW LOCKWASHERS (13) TO SECURE TANK TO SUPPORT BAR (15). TIGHTEN CAPSCREWS (11).
- 4. CONNECT FUEL LINES (3 AND 4), HYDRAULIC LINES (5 THROUGH 10) AND ELECTRICAL WIRE (2). TIGHTEN NUT (1) TO SECURE ELECTRICAL WIRE (2).
- 5. FILL FUEL TANK WITH DIESEL FUEL OIL AND FILL HYDRAULIC TANK WITH CLEAN HYDRAULIC OIL, TM10-3930-660-10.
- 6. CONNECT NEGATIVE BATTERY CABLE, TM10-3930-660-20.



### **CHAPTER 5**

# **COOLING SYSTEM MAINTENANCE**

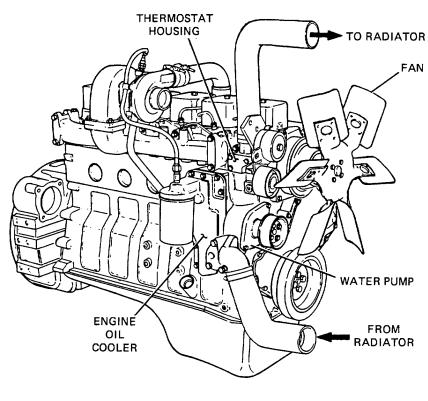
## Section I. DESCRIPTION AND DATA

# 5-1. GENERAL.

This chapter covers maintenance procedures for the engine cooling system components, as well as principles of operation.

### 5-2. PRINCIPLES OF OPERATION.

- a. <u>System Operation</u>. Coolant liquid is circulated through passages in engine cylinder block and through the engine oil cooler by an engine-driven water pump. The water pump also serves to force coolant to flow through the radiator, from top to bottom, as long as thermostat is open to allow flow to radiator. As coolant flows downward in radiator, airflow produced by the engine fan is forced through the radiator. Heat is removed from the coolant in this way.
- b. Water Pump. The water pump is a centrifugal-type unit that is driven by belt off the crankshaft pulley.
- c. <u>Thermostat</u>. The thermostat is a heat-operated valve which serves to regulate coolant temperature within a range that provides the most efficient engine operation. The thermostat is a modulating type, which begins to open at a coolant temperature of 1800 F and is fully open when coolant temperature reaches 190°.



# Section II. COOLING SYSTEM MAINTENANCE PROCEDURES

# COOLING SYSTEM MAINTENANCE TASK SUMMARY

TASK PARA.	PROCEDURES	PAGE NO.
5-3	Radiator - Repair	5-3

### 5-3. RADIATOR - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

### **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Tool Kit, Machinists: Post, Camp and Station

## **Equipment Condition**

Radiator removed, TM10-3930-660-20.

### **DISASSEMBLY**

- 1. IF NECESSARY, REMOVE EIGHT SCREWS (1) AND SHROUD (2) FROM RADIATOR (3).
- 2. REMOVE DRAIN PETCOCK (4).

### **CLEANING**

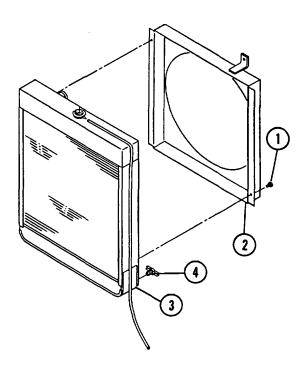
## WARNING

Do not exceed 30 psig nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

## **CAUTION**

Do not attempt to clean radiator core fins with any sharp instrument. A sharp instrument may damage core, leading to leakage from core.

- 1. REMOVE DIRT AND OTHER DEBRIS FROM CORE FINS USING COMPRESSED AIR.
- 2. REMOVE ANY SURFACE CORROSION FROM UPPER AND LOWER TANKS USING A WIRE BRUSH OR SANDPAPER.



# 5-3. RADIATOR - REPAIR (Cont'd)

### **INSPECTION**

- INSPECT CORE AND UPPER AND LOWER TANKS FOR SMALL HOLES, OR FOR OTHER EVIDENCE OF MINOR LEAKS. REPAIR MINOR LEAKS BY SOLDERING OR BRAZING.
- 2. CHECK FILLER CAP OPENING PRESSURE IN A SUITABLE TESTER. OPENING PRESSURE MUST BE A MINIMUM OF 7 PSI.
- 3. CHECK DRAIN PETCOCK (4) FOR DAMAGED THREADS OR SIGNS OF LEAKAGE.

### **ASSEMBLY**

- 1. INSTALL DRAIN PETCOCK (4).
- 2. ASSEMBLE SHROUD (2) TO RADIATOR (3) AND SECURE WITH EIGHT SCREWS (1).

#### **CHAPTER 6**

### **ELECTRICAL SYSTEM MAINTENANCE**

#### Section I. DESCRIPTION AND DATA

#### 6-1. GENERAL.

This chapter covers maintenance procedures for the electrical system components, as well as principles of operation.

#### 6-2. PRINCIPLES OF OPERATION.

a. <u>Charging System.</u> The charging system includes the alternator, rectifier and voltage regulator. The rectifier and voltage regulator are integral with the alternator. The basic function of the charging system is to maintain the vehicle battery voltage (charge) at the specified level. The alternator is an ac generator that is belt-driven by the engine crankshaft pulley. The ac produced in the alternator stator windings is converted to dc by action of a diode rectifier bridge. The initial output from the alternator is made possible by residual magnetism in the rotor poles. As the rotor turns, the magnetic lines of force produced by the residual magnetism cut through the stator windings and current flow is produced by the stator windings. As engine speed increases, alternator rotor speed also increases. Current flow produced by the stator increases accordingly.

A portion of the current produced in the stator windings is shunted through a diode trio to the field winding. The diode trio converts the ac output of the stator windings to dc for application to the field winding. Current flow through the field winding increases the strength of the magnetic field surrounding the rotor, and a resultant increase in stator current occurs. Current flow in the field winding circuit is controlled electronically by the regulator. The regulator, in effect, monitors battery voltage and switches on and off several times a second in normal operation to maintain the required battery voltage level.

b. <u>Starting Motor.</u> The function of the starting motor is to turn the engine flywheel at a fast enough rate to initiate engine combustion.

An electric solenoid, activated by the START switch, pulls the starting motor drive pinion into engagement with the ring gear on the engine flywheel. At the same time, movement of the solenoid closes a set of switch contacts which connect the starting motor armature to the battery through a set of four carbon brushes. Current flow in the armature causes the armature to rotate. The drive pinion then rotates and turns the engine flywheel. When the engine starts, centrifugal force resulting from increased flywheel speed, moves the starting motor pinion out of engagement with the flywheel ring gear. Releasing the START switch causes the solenoid to de-energize and disconnect the battery from the starting motor.

# Section II. ELECTRICAL SYSTEM MAINTENANCE PROCEDURES

# **ELECTRICAL SYSTEM MAINTENANCE TASK SUMMARY**

TASK PARA.	PROCEDURES	PAGE NO.
6-3	Alternator - Repair/Test	6-3
6-4	Starter - Repair	6-11
6-5	Boom Electrical Box Assembly - Repair	6-19
6-6	Battery Boxes - Repair	6-22
6-7	Cab Wiring Harness - Replace/Repair	6-24
6-8	Main Wiring Harness - Replace	6-29
6-9	Electric Joystick - Repair	6-33

#### 6-3. ALTERNATOR - REPAIR/TEST

#### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Testing
- e. Assembly

# **Initial Setup**

#### Tools

Tool Kit, Machinists: Post, Camp and Station

# **Equipment Condition**

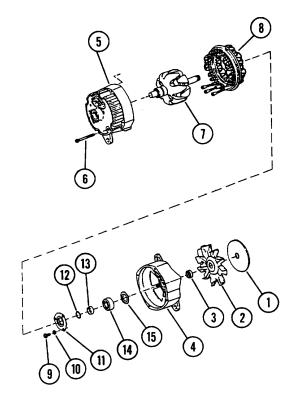
Alternator removed, TM10-3930-660-20. Alternator pulley removed, TM10-3939-660-20.

#### Materials/Parts

Bearing Retainer (11)
Delco-Remy Lubricant
(App. B, Item 15)
Gasket (12)
Lockwashers (10, 30)
Sandpaper, No. 100 (App. B, Item 39)
Screw and Lockwasher Assembly (25)
Seal (41)
Springwashers (22)

#### **DISASSEMBLY**

- REMOVE BAFFLE (1), FAN (2) AND COLLAR (3).
- 2. MATCH MARK FRAMES (4) AND (5) TO ENSURE CORRECT ORIENTATION DURING ASSEMBLY.
- REMOVE FOUR THROUGH BOLTS (6) AND SEPARATE DRIVE END FRAME (4) AND ROTOR (7) FROM SLIP RING END FRAME (5) AND STATOR (8).
- 4. DISASSEMBLE DRIVE END FRAME (4) COMPONENTS.
  - a. Remove rotor (7) using a suitable press.
  - b. Remove three screws (9), three lockwashers (10), bearing retainer (11) and gasket (12). Discard lockwashers (10), bearing retainer (11) and gasket (12).
  - c. Remove collar (13).



- d. Remove ball bearing (14) by pressing towards inside of drive end frame (4). Apply pressure against I.D. of bearing (14).
- e. Remove dust shield (15).
- REMOVE THREE NUTS (16) THAT CONNECT STATOR LEAD TERMINAL CLIPS (17) TO DIODE TRIO (18).
- 6. REMOVE STATOR (8) FROM SLIP RING END FRAME (5).
- 7. DISASSEMBLE SLIP RING END FRAME (5) COMPONENTS.
  - a. Remove insulated screw (19) securing diode trio (18) to brush and holder assembly (20).
     Remove diode trio (18).

#### **NOTE**

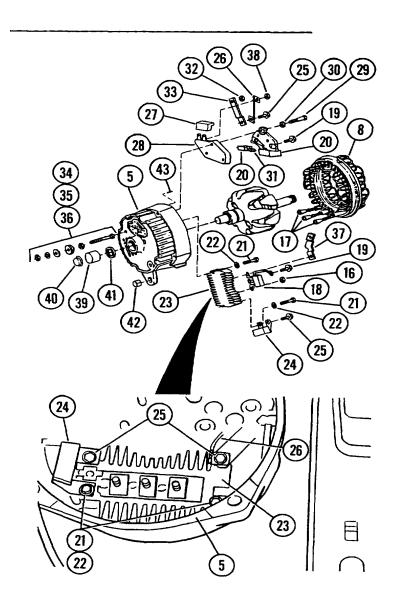
Screws (21) and springwashers (22) are located on the rectifier bridge (23), closest to outside of frame (5). One of the screws (21) secures the lower contact of capacitor (24).

b. Remove two screws (21) and two springwashers (22) from rectifier bridge (23). Discard springwashers (22).

#### **NOTE**

Screw and lockwasher assemblies (25) are located on the rectifier bridge (25), closest to center of frame (5). One assembly (25) secures the upper contact of capacitor (24). The other assembly (25) secures wire lead (26).

 c. Remove two screw and lockwasher assemblies (25) from rectifier bridge (23). Remove capacitor (24) and rectifier bridge (23) from frame (5). Discard screw and lockwasher assemblies (25).



- d. Remove rubber cover (27) from terminals of regulator (28.
- e. Remove insulated screw (19), screw (29), and lockwasher (30), securing brush and holder assembly (20), brush springs (31), and regulator (28). Discard lockwasher (30). Remove parts (20), (28), and (31) from frame (5).

- f. If necessary, remove nut (32), connector (33), and battery terminal assembly parts (34).
- g. If necessary, remove relay terminal cap (35), relay terminal assembly parts (36), and connector (37).
- h. If necessary, remove nut (38) and wire lead (26) from regulator (28).

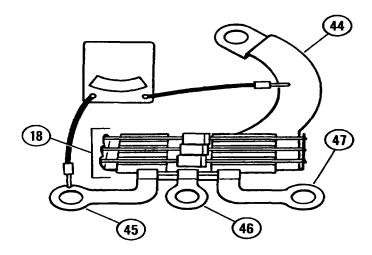
#### **NOTE**

If roller bearing (39) is not being removed, apply pressure sensitive tape over it for protection against dirt. Do not use friction tape or other tape that will leave a residue behind.

- If necessary for replacement, push roller bearing (39) out of frame (5) and remove seal (41) and plug (40). Discard seal (41).
- j. If necessary, remove bushing (42) and pin (43) from frame (5).

#### **CLEANING**

- 1. CLEAN BRUSHES USING SOFT, DRY CLOTH.
- 2. CLEAN SLIP RINGS ON ROTOR (7).
  - a. Place rotor (7) in a lathe, with slip ring of shaft free.
  - While rotor is spinning in lathe, hold No. 00 sandpaper or 400 grit silicon carbide paper against slip ring surface.
  - c. After polishing slip rings, clean using low pressure (15 psi maximum) compressed air.
  - d. Clean ball bearing (14) in dry cleaning solvent to remove lubricant.



#### **INSPECTION**

- INSPECT BEARINGS (14 AND 39) FOR ROUGH ROTATION OR VISIBLE DAMAGE.
- 2. INSPECT BRUSHES (20) FOR EXCESSIVE WEAR.
- 3. INSPECT BRUSH SPRINGS (31) FOR DISTORTION OR DISCOLORATION

#### **TESTING**

- 1. TEST DIODE TRIO (18).
  - a. Remove diode trio (18).
  - b. Connect ohmmeter between diode trio single connector (44) and each of the other connectors (45, 46, and 47) in turn. Observe resistance reading on ohmmeter.
  - Reverse ohmmeter leads, or reverse meter polarity, and repeat STEP b, above.
  - d. At one polarity, resistance reading should be low and at the other polarity, resistance reading should be very high, if diodes are good.

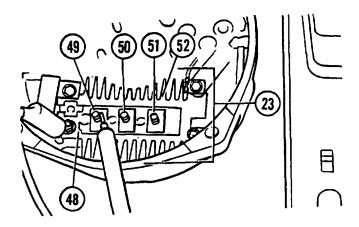
 e. If both readings on same set of connectors are either high or low, the associated diode is faulty and entire diode trio must be replaced.

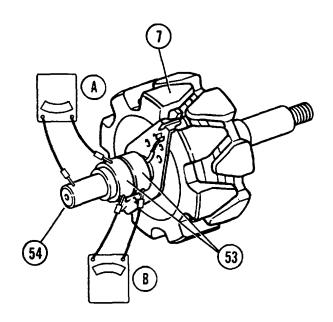
# 2. TEST RECTIFIER BRIDGE (23).

- a. Connect ohmmeter from grounded heat sink (48) to diode terminal (49) and note resistance reading.
- Reverse ohmmeter leads or reverse meter polarity and again note resistance reading.
- c. At one polarity, resistance reading should be low and at the other polarity, resistance reading should be very high, if diode is good. If diode is faulty, both readings will be either low or high.
- d. Repeat above sequence between grounded heat sink (48) and diode terminals (50 and 51), and then between insulated heat sink (52) and each diode terminal (49, 50 and 51).
- e. If any set of readings indicates a faulty diode, replace complete rectifier bridge (23).

# 3. TEST ROTOR (7) FOR SHORT OR OPEN CIRCUITS.

- a. Connect ohmmeter between slip rings (53), in turn, and rotor shaft (54) (connection A). Observe resistance reading on ohmmeter.
- Resistance reading should be high (infinite). If not, rotor (7) is defective and must be replaced.
- c. Connect ohmmeter leads across slip rings (53) (connection B). Observe resistance reading on ohmmeter.

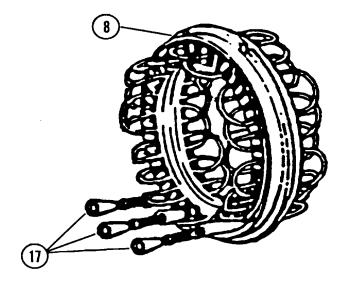


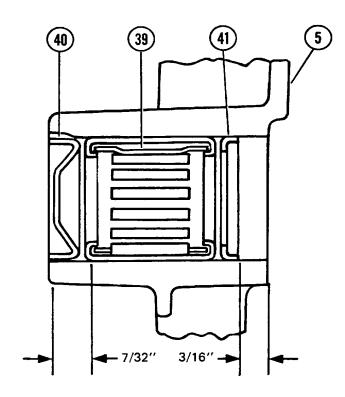


- d. A high (infinite) resistance reading in STEP c indicates an open rotor winding and rotor (7) must be replaced.
- 4. TEST STATOR (8) FOR OPEN OR GROUNDED WINDINGS.
  - a. Using an ohmmeter set to low scale, measure resistance through stator windings. Connect ohmmeter to terminal clips (17), from each outside clip to center clip and then between two outside clips.
  - b. Measure resistance from each terminal clip (17) to stator frame to check for grounded windings. A low resistance reading between any terminal clip (17) and stator frame indicates a grounded winding, and stator (8) must be replaced as a unit.

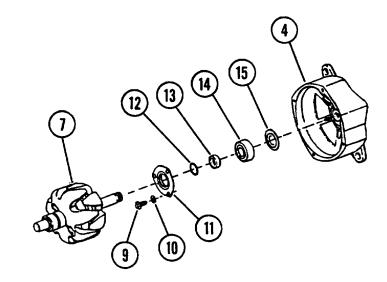
#### **ASSEMBLY**

- 1. INSTALL ROLLER BEARING (39) TO SLIP RING END FRAME (5).
  - a. Press new roller bearing (39) into slip ring end frame (5) from outside to inside, to a depth of 7/32 inch as shown.
  - Fill plug (40) with Delco-Remy lubricant to a level sufficient to fill grease reservoir approximately one-half full.
  - c. Install plug (40), making sure that some lubricant touches roller bearing (39).
  - d. Press new seal (41) into slip ring end frame (5) bore to a depth of 3/16 inch, as shown.





- 2. INSTALL BALL BEARING (14) TO DRIVE END FRAME (4).
  - a. Install dust shield (15).
  - Apply small amount of Delco-Remy lubricant to ball bearing (14) race. Rotate bearing race to distribute lubricant.
  - c. Press ball bearing (14) into frame (4) from inside to outside. Sealed side of bearing must face out, away from new bearing retainer (11).
  - d. Fill grease cavity approximately one-half full of Delco-Remy lubricant. Arrange lubricant so some will touch ball bearing (14) after bearing retainer (11) is installed.
  - e. Install new gasket (12), new bearing retainer (11), three new lockwashers (10), and three screws (9).
- 3. INSTALL COLLAR (13) ON ROTOR SHAFT AND PRESS ROTOR (7) THROUGH BALL BEARING (14) AND BORE IN DRIVE END FRAME (4) USING A SUITABLE PRESS.
- 4. ASSEMBLE SLIP RING END FRAME COMPONENTS.
  - a. If removed, install pin (43) and bushing (42) to frame (5).
  - b. If removed, secure wire lead (26) to regulator (28) with nut (38).
  - c. If removed, install connector (37), relay terminal assembly parts (36), and relay terminal cap (35).
  - d. If removed, install battery terminal assembly parts (34), connector (33), and nut (32).



- e. Place regulator (28), brush springs (31), and brush and holder assembly (20) inside frame (5).
- f. Install screw (29), new lockwasher (30), and insulated screw (19) to secure regulator (28), brush spring (31), and brush and holder assembly (20) to frame (5).
- d. Install rubber cover (27) to terminals of regulator (28).
- e. Place rectifier bridge (23) inside frame (5).

# **NOTE**

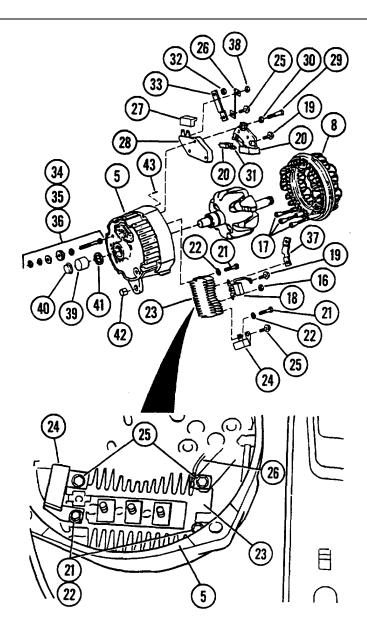
Holes for screw and lockwasher assemblies (25) are located on the rectifier bridge (23), closest to center of frame (5). One assembly (25) secures the upper contact of capacitor (24). The other assembly (25) secures wire lead (26).

f. Secure wire lead (26) and top contact of capacitor (24) to rectifier bridge (23) with two new screw and lockwasher assemblies (25).

#### **NOTE**

Holes for screws (21) and springwashers (22) are located on the rectifier bridge (23), closest to outside of frame (5). One of the two screws (21) secures the lower contact of capacitor (24).

- g. Secure rectifier bridge (23) to frame (5) with two screws (21) and two new spring washers (22).
- i. Secure diode trio (18) to brush and holder assembly (20) with insulated screw (19).



- 5. CONNECT STATOR TERMINAL CLIPS (17) TO DIODE TRIO (18) AND RECTIFIER BRIDGE (23) WITH THREE NUTS (16).
- 6. PLACE STATOR (8) ON SLIP RING END FRAME (5).
- 7. ASSEMBLE SLIP RING END FRAME (5) AND DRIVE END FRAME (4).

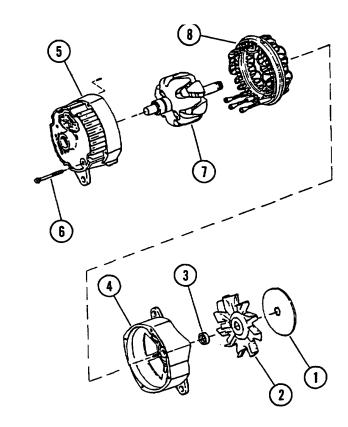
#### **CAUTION**

Be careful as rotor (7) is placed in slip ring end frame (5), not to damage brushes or seal (41).

#### **NOTE**

To secure brushes during rotor (7) installation, push brushes into brush and holder assembly (20) and insert a stiff piece of wire through hole provided in slip ring end frame (5).

- a. Position drive end frame (4), with rotor (7), on slip ring end frame (5). Align match marks that were made during disassembly.
- b. Remove wire used to hold up brushes during rotor (7) installation. (NOTE above).
- c. Install and tighten four through bolts (6).
- d. Install collar (3), fan (2) and baffle (1) on rotor shaft.
- 7. INSTALL ALTERNATOR PULLEY, TM10-3930-660-20.
- 8. INSTALL ALTERNATOR TO ENGINE, TM10-3930-660-20.



#### 6-4. STARTER - REPAIR

# This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

#### **Initial Setup**

# **Tools**

Tool Kit, Machinists: Post, Camp and Station

# **Equipment Condition**

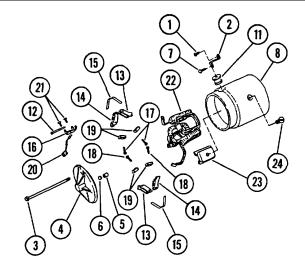
Starter removed, TM10-3930-660-20.

# Materials/Parts

Gasket (27, 32) Grommet (11) Lockwasher (31 and 38) Oil, Lubricating, Engine (App. B, Item 26)

# **DISASSEMBLY**

- 1. CLAMP STARTER, DRIVE END DOWN, IN A VISE.
- 2. REMOVE SCREW (1) TO DISCONNECT CONNECTOR (2) FROM SOLENOID SWITCH TERMINAL.
- 3. REMOVE TWO THROUGH BOLTS (3) AND COIL END FRAME (4).
- 4. IF NECESSARY FOR REPLACEMENT, REMOVE BEARING (5) AND WICK (6).
- 5. REMOVE SCREW (7) AND CAREFULLY LIFT FIELD FRAME (8) AND ASSOCIATED PARTS OFF ARMATURE (9) AND DRIVE HOUSING (10).
- 6. REMOVE PARTS FROM FIELD FRAME (8).
  - a. Remove connector (2) and grommet (11).
  - b. Remove two pins (12) to free holders (13 and 14) and springs (15) from supports (16).



- Remove four screws (17 and 18) and four brushes (19). Two brush ground leads (20) are also attached with screws (17).
- d. Remove brushes (19) from holders (13 and 14).
- e. If necessary, remove four rivets

   (21) and two supports (16). Discard rivets (21).

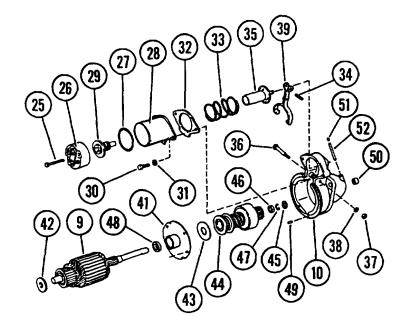
#### NOTE

Remove field winding coil (22) only if known to be grounded or open. If it is being removed, use a pole spreader and a pole shoe screwdriver.

- f. Match mark all four shoes (23) and adjacent area of field frame (8), to ensure proper installation.
- g. Remove eight screws (24), four shoes (23) and field winding coil (22).

# 7. REMOVE SOLENOID SWITCH AND RELATED PARTS.

- a. Remove two capscrews (25) and separate cover (26) and gasket (27) from solenoid switch housing (28). Remove contact (29). Discard gasket (27).
- b. Remove two screws (30) and lockwashers (31). Discard lockwashers (31).
- c. Remove solenoid switch (28), gasket (32) and plunger return spring (33). Discard gasket (32).
- d. Remove pin (34) and plunger (35).
- e. Remove screw (36), nut (37), lockwasher (38) and shift lever (39). Discard lockwasher (38).



#### 8. REMOVE ARMATURE AND MOTOR DRIVE.

- a. Remove brake washer (42) and armature (9), with washer (43), motor drive (44) and thrust washer (45).
- b. Using a short pipe nipple, or other suitable metal cylinder, and a hammer, drive pinion stop (46) toward motor drive (44) until retaining ring (47) is exposed. Remove retaining ring (47).
- c. Separate armature (9), center bearing plate (41), washer (43), motor drive (44) and pinion stop (46).
- d. If required, remove center bearing (48) from center bearing retainer (41).
- 9. REMOVE PARTS (49 THROUGH 52) FROM DRIVE HOUSING (10), AS REQUIRED, FOR REPLACEMENT.

# **CLEANING**

# **CAUTION**

Do not clean starter parts in dry cleaning solvent. Dry cleaning solvent may damage certain electrical parts.

CLEAN STARTER PARTS IN MINERAL SPIRITS AND DRY USING LOW PRESSURE COMPRESSED AIR OR CLEAN LINT-FREE CLOTH.

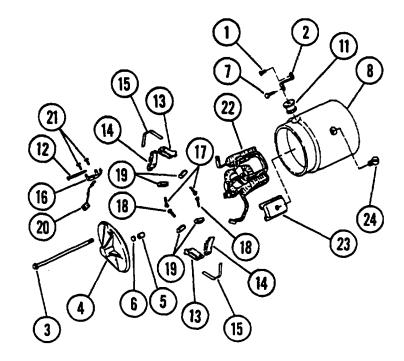
#### **INSPECTION**

- 1. BRUSH COMPONENTS.
  - a. Check brush (19) lengths against length of new brush. Brushes that are less than two-thirds the length of a new brush must be replaced.
  - b. An oil soaked brush must also be replaced.
  - c. Check to ensure that brushes fit well in holders (13 and 14), but without binding.
  - d. Inspect brush springs (15) for distortion or discoloration.

# **CAUTION**

Do not turn down commutator nor undercut insulation between commutator bars. Replace armature if commutator cannot be restored satisfactorily in STEP 2, below.

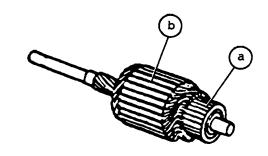
- 2. CHECK CONDITION OF COMMUTATOR, AND CLEAN, IF NECESSARY, USING NO. 240 GRIT EMERY PAPER.
- 3. CHECK FOR SHORT CIRCUITS IN ARMATURE USING A GROWLER AND STEEL STRIP.
  - a. Rotate armature in growler.
  - Hold steel strip (e.g., hacksaw blade) across armature slots as armature rotates. Steel strip will vibrate as slot between shorted bars passes under steel strip.
  - If short circuit is detected, check for build up of copper dust or other conductive material between commutator bars.

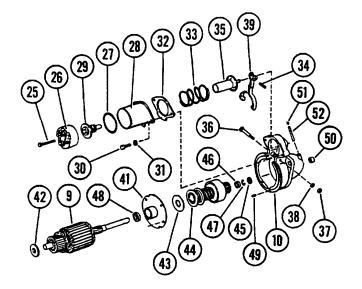


- 4. CHECK ARMATURE FOR GROUNDS OR OPEN CIRCUITS.
  - a. Check for grounds by measuring resistance between commutator (a) and one armature bar (b). Set ohmmeter on highest scale when taking measurement.
  - b. Switch ohmmeter to lowest scale.
  - Place ohmmeter leads against two adjacent commutator bars (a) and observe ohmmeter. Ohmmeter needle should swing to zero and remain.
  - d. Repeat check for all commutator bars (a) by moving one ohmmeter lead at a time. There must be continuity between each pair of bars.

#### **ASSEMBLY**

- 1. IF REMOVED, INSTALL BEARING (50), WICK (52), PLUG (51) AND PIN (49).
  - a. Soak wick (52) and surface of bearing (50) in OE/HDO-10 engine oil.
  - b. Press bearing (50) into bore until even with end of drive housing (10).
  - c. Install wick (52) and plug (51).
  - d. Install pin (49).
- 2. IF REMOVED, PRESS CENTER BEARING (48) INTO CENTER BEARING RETAINER (41) UNTIL FLUSH WITH FRONT FACE OF RETAINER.
- 3. ASSEMBLE ARMATURE (9) AND MOTOR DRIVE (44) COMPONENTS.
  - a. Install center bearing retainer(41), washer (43) and motor drive(44) on armature shaft.

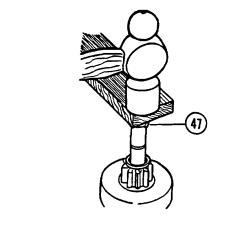


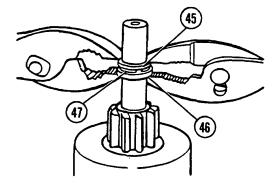


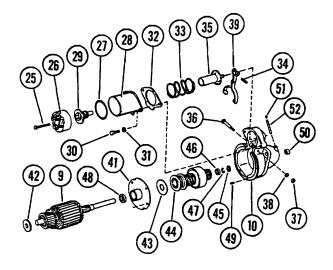
- Install pinion stop (46) (cupped side facing out) and retaining ring (47) on armature shaft. Retaining ring (47) may have to be forced over end of armature shaft using a hammer and piece of wood, as shown.
- c. Place thrust collar (45) on retaining ring (47) and force pinion stop (46) over retaining ring (47), using two pliers as shown.
- 4. ASSEMBLE ARMATURE/MOTOR DRIVE AND SOLENOID SWITCH TO DRIVE HOUSING (10).
  - a. Clamp drive housing (10) in a padded vise.
  - b. Position center bearing retainer (41) to drive housing (10).
  - c. Place shift lever (39) in drive housing (10) and secure with screw (36), nut (37) and new lockwasher (38).
  - d. Install plunger (35) and pin (34).
  - e. Install plunger return spring (33), and new gasket (32).
  - f. Install solenoid switch (28), two screws (30) and two new lockwashers (31).
  - g. Position contact (29) between cover (26) and solenoid switch housing (28). Align new gasket (27) and secure cover (26) to solenoid switch housing (28) with two capscrews (25).
- 5. INSTALL PARTS IN FIELD FRAME (8).

#### **NOTE**

If pole shoes (23) have one long lip, install pole shoes so long lip points in direction of armature rotation. Also, observe match marks made before removal.





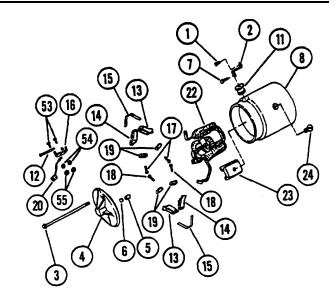


a. If removed, install field coil (22) and pole shoes (23).
 Secure pole shoes (23) with eight screws (24). Use care to prevent grounding or shorting coils as pole shoes are secured.

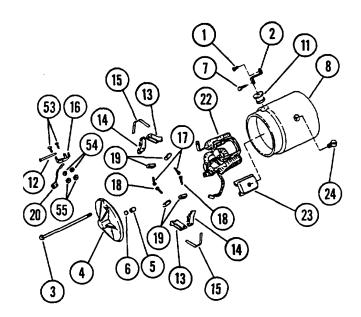
#### NOTE

If supports (16) were removed, use service parts (53) through (55) to secure supports (16) during step b.

- b. If removed, secure two supports (16),and two brush ground leads (20) with four studs (53), four lockwashers (54), and four nuts (55).
- c. Install two springs (15), two grounded brush holders (13), two insulated brush holders (14) and two pins (12).
- d. Install two brushes (19) in grounded brush holders (14). Secure brushes (19) and brush ground leads (20) using two screws (17).
- e. Install two brushes (19) in insulated brush holders (13) and secure with two screws (18).
- f. Install new grommet (11) and connector (2).
- 6. PLACE BRAKE WASHER (42) ON ARMATURE (9).
- 7. CAREFULLY LOWER FIELD FRAME (8) ONTO ARMATURE (9), MAKING CERTAIN THAT BRUSHES (19) CLEAR COMMUTATOR BARS AND NO INTERFERENCE OCCURS BETWEEN POLE SHOES (23) AND ARMATURE (9).INSTALL SCREW (7) TO SECURE CONNECTOR (2) TO FIELD COIL (22) TERMINAL..



- 8. IF REMOVED, PRESS NEW BEARING (5) INTO BORE IN COIL END FRAME (4). SOAK WICK (6) IN OE/HDO-10 ENGINE OIL, AND INSTALL.
- 9. CHECK TO BE SURE THAT BRUSHES (19) ARE MAKING PROPER CONTACT WITH COMMUTATOR, AND THAT ALL INTERNAL ELECTRICAL CONNECTIONS HAVE BEEN CORRECTLY MADE. THEN,INSTALL COIL END FRAME (4) AND THROUGH BOLTS (3).SECURE CONNECTOR (2) TO SOLENOID SWITCH (28) TERMINAL USING SCREW (1).



#### 6-5. BOOM ELECTRICAL BOX ASSEMBLY - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# INITIAL SETUP

Tools

Tool Kit, Automotive Mechanics

**Equipment Condition** 

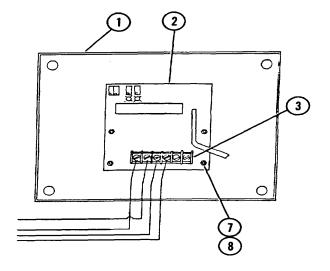
Vehicle parked on level surface and forks lowered to ground. Negative battery cable disconnected, TM10-3930-660-20. Materials/Parts

Cable Ties (12) Grommet (14) Grommets (15)

Lockwashers (5, 17, 20) Tags (App. B, Item 52)

#### **DISASSEMBLY**

- 1. REMOVE FOUR SCREWS (NOT SHOWN) AND ENCLOSURE COVER (1).
- 2. IF REQUIRED, REMOVE AUTOMATIC LEVELER CIRCUIT BOARD (2).
  - a. Tag and disconnect four wires connected circuit board (2) terminal strip (3).
  - b. Remove four screws (4) and four lockwashers (5) from connector (6). Connector is part of circuit board (2). Discard lockwashers (5).
  - c. Remove four nuts (7) and four screws (8) to remove circuit board (2).



# 6-5. BOOM ELECTRICAL BOX ASSEMBLY - REPAIR (Cont'd)

- 3. REMOVE CABLES (9, 10 AND 11) AS NECESSARY FOR REPLACEMENT.
  - a. Cut cable tie (12) from cable to be removed.
  - b. Tag and disconnect cable wires from terminal strip (13).
  - Remove grommet (14 or 15) by pushing to outside of enclosure, using care not to damage grommet.
  - d. Remove grommet (14 or 15) from cable (9,10 or 11).
- 4. REMOVE WIRE ASSEMBLY (18).
  - a. Remove screw (16) and lockwasher (17). Discard lockwasher (17).
  - b. Disconnect wire assembly (18) from lower terminal strip (13) and from terminal strip (3), if applicable. Remove wire assembly (18).
- 5. REMOVE EIGHT SCREWS (18), NUTS (19)
  AND LOCKWASHERS (20) TO REMOVE
  TERMINAL STRIPS (13).DISCARD
  LOCKWASHERS (20).
- 6. REMOVE TWO JUMPER TERMINALS (21).

# 

## **INSPECTION**

- VISUALLY INSPECT CABLES (9,10 AND 11) FOR DAMAGE OR OTHER DEFECTS.
- 2. INSPECT GROMMETS (14 AND 15) FOR TEARS, DETERIORATION OR OTHER CONDITION WHICH MAY ALLOW MOISTURE OR DIRT INTO ENCLOSURE.REPLACE DEFECTIVE GROMMETS.
- 3. USING AN OHMMETER, CHECK CONTINUITY OF INDIVIDUAL WIRES IN CABLES (9, 10 AND 11), BETWEEN CONNECTOR PINS AND TERMINAL LUGS.REPLACE COMPLETE CABLE IF OPEN WIRES ARE DETECTED.

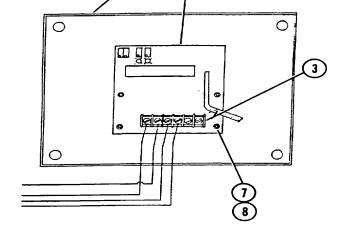
#### **CLEANING**

SEE CLEANING INSTRUCTIONS, PARA 2-10.

# 6-5. BOOM ELECTRICAL BOX ASSEMBLY - REPAIR (Cont'd)

#### **ASSEMBLY**

- 1. CONNECT JUMPER TERMINALS (21) TO PROPER TERMINALS ON LOWER TERMINAL STRIP (13).
- 2. INSTALL TERMINAL STRIPS (13).SECURE WITH EIGHT SCREWS (18), NUTS (19) AND NEW LOCKWASHERS (20).
- 3. INSTALL WIRE ASSEMBLY (18).
  - a. Connect wire assembly (18) to terminal strips (3 and 10), as shown.
  - b. Attach to panel using screw (16) and new lockwasher (17).
- 4. INSTALL CABLES (9, 10 AND 11).
  - a. Install grommet (14 or 15), as applicable, on cable to be installed.
  - b. Carefully push cable through entrance in enclosure and work grommet (14 or 15) into place in cable entrance.
  - c. Connect cable wires to proper terminals on terminal strip (13).
  - d. Install new cable ties (10), as necessary.
- 5. INSTALL AUTOMATIC LEVELER CIRCUIT BOARD (2).
  - a. Secure circuit board (2) to enclosure cover (1), using four screws (7) and nuts (8).
  - b. Install connector (6), using four screws (4) and new lockwashers (5).
  - c. Connect four wires to terminal strip (3). Observe tags placed board removal



- 6. INSTALL ENCLOSURE COVER (1) USING FOUR SCREWS (NOT SHOWN).
- 7. CONNECT NEGATIVE BATTERY CABLE, during circuit TM10-3930-660-20.

#### 6-6. BATTERY BOXES - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

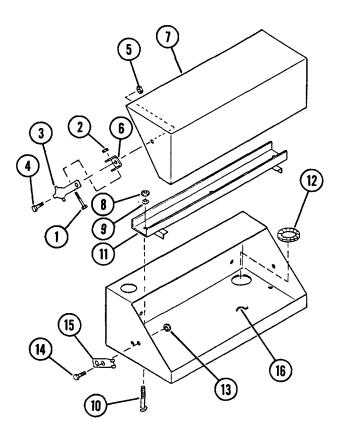
Battery box removed, TM10-3930-660-20.

# **DISASSEMBLY**

- REMOVE COVER (7) MOUNTED PARTS.
  - a. Remove two screws (1), two nuts (2) and two latch anchors (3).
  - b. Remove two screws (4), two nuts (5) and two latch brackets (6).
- 2. REMOVE BOX (16) MOUNTED PARTS.
  - a. Remove three nuts (8), three flatwashers (9), three screws (10) and hold-down (11).
  - b. Remove two nuts (13), two screws (14) and two latch hooks (15).
  - c. If necessary, remove grommet (12).

# **CLEANING**

SEE CLEANING INSTRUCTIONS, PARA 2-10.



# 6-6. BATTERY BOXES - REPAIR (Cont'd)

#### **INSPECTION**

- CHECK COVER (7) AND BOX (16) FOR DAMAGE OR EXCESSIVE CORROSION. STRAIGHTEN MINOR DENTS. IF DAMAGE IS SEVERE, REPLACE PART.
- 2. INSPECT LATCH PARTS (3, 6 AND 15) FOR CRACKS OR DISTORTION WHICH MAY PREVENT PROPER LATCHING. REPLACE PARTS AS NECESSARY.
- INSPECT GROMMET (12) FOR TEARS OR DETERIORATION. REPLACE IF NECESSARY.

#### **ASSEMBLY**

- INSTALL BOX (16) MOUNTED PARTS.
  - a. If removed, install grommet (12).
  - b. Install two latch hooks (15), two screws (14) and two nuts (13).
  - c. Install hold-down (11), three screws (10), three flatwashers (9) and three nuts (8).
- 2. INSTALL COVER (7) MOUNTED PARTS.
  - a. Install two latch brackets (6), two screws (4) and two nuts (5).
  - b. Install two latch anchors (3), two screws (1) and two nuts (2).
- 3. INSTALL BATTERY BOXES, TM10-3930-660-20.

#### 6-7. **CAB WIRING HARNESS - REPLACE/REPAIR**

This task covers:

- Removal a.
- b. Inspection
- Installation C.

# **Initial Setup**

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

**Equipment Condition** 

**Negative Battery Cable** disconnected, TM10-3939-660-20.

#### **REMOVAL**

#### NOTE

Tag all electrical leads as removed for use during installation.

- UNPLUG FORTY-FOUR FEMALE 1 CONNECTORS (2) FROM MALE CONNECTORS (1).
- DISCONNECT WIRES FROM SIX LAMP HOLDERS (3).
- 3. DISCONNECT EIGHTEEN CONNECTORS (4), TWENTY-SEVEN CONNECTORS (5), CONNECTOR (6), SIX CONNECTORS (7), THIRTY-FOUR CONNECTORS (8) AND **ELEVEN CONNECTORS (9) FROM DEVICES** INDICATED.
- 4. DISCONNECT TWO CONNECTORS (10) FROM STEER SELECT VALVE.
- REMOVE FOURTEEN NUTS (11) TEN 5. LOCKWASHERS (12) SIX LOCKWASHERS (13) NUT (14) LOCKWASHER (15), FIVE FLATWASHERS (16) TWELVE

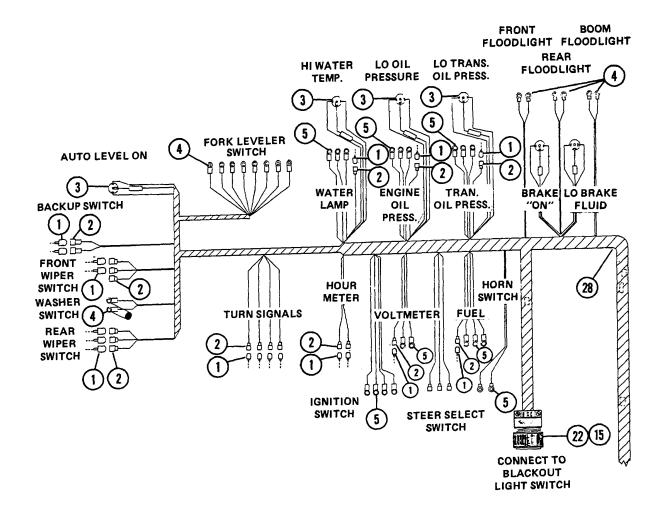
CLAMPS (17) AND FOUR LOCKWASHERS (18). DISCARD LOCKWASHERS (12),

- REMOVE CABLE CLAMPS (19-21) AND 6. DISCONNECT CONNECTORS (22-25).
- 7. CAREFULLY PUSH OUT TWO GROMMETS (26) AND GROMMET (27) FROM FRONT HARNESS SECTION (28).
- 8. REMOVE FRONT HARNESS SECTION (28). (13) (15) AND (18).

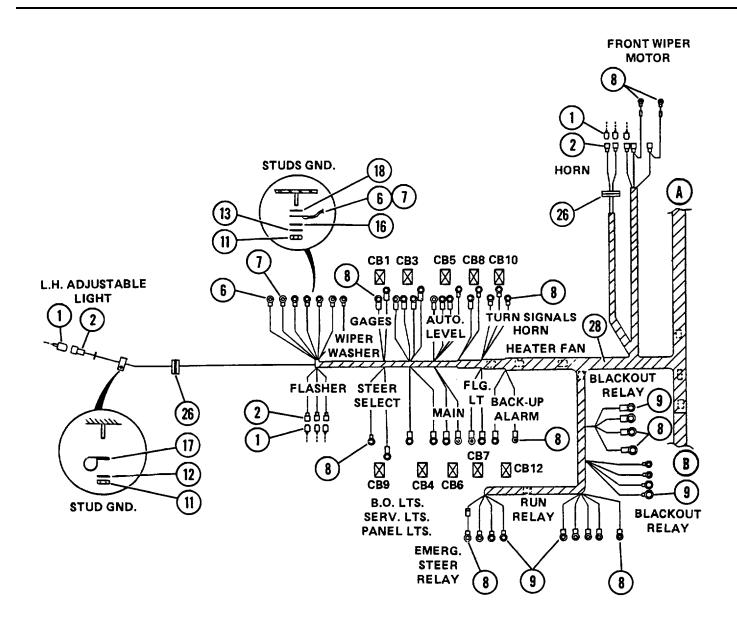
Materials/Parts

Lockwashers (12), (13), (15), (18)

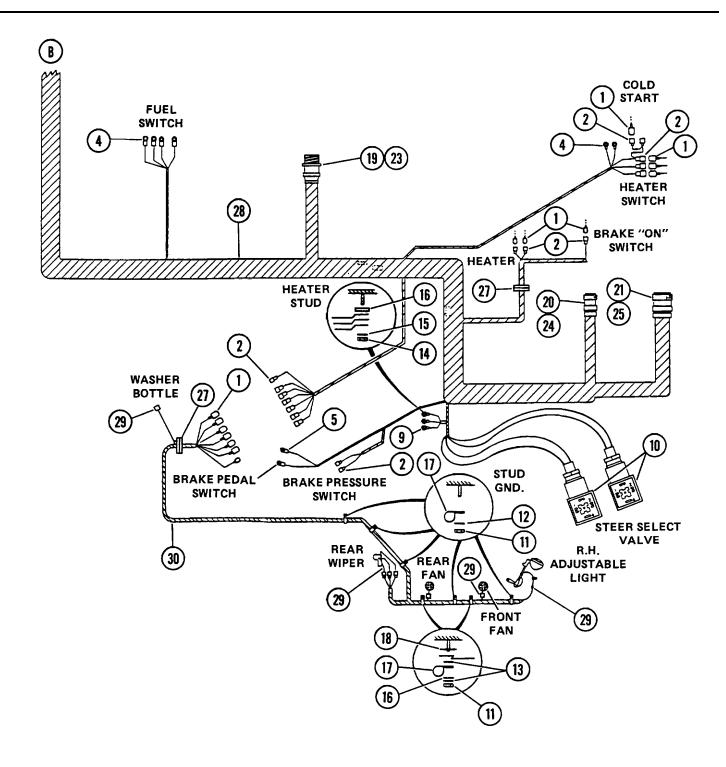
# 6-7. CAB WIRING HARNESS - REPLACB/REPAIR (Cont'd)



# 6-7. CAB WIRING HARNESS - REPLACE/REPAIR (Cont'd)



# 6-7. CAB WIRING HARNESS - REPLACE/REPAIR (Cont'd)



#### 6-7. CAB WIRING HARNESS - REPLACE/REPAIR (Cont'd)

9. DISCONNECT SEVEN TERMINALS (29) FROM DEVICES INDICATED. REMOVE REAR WIRE HARNESS SECTION (30) AND GROMMET (27).

#### INSPECTION

- CHECK CONTINUITY OF INDIVIDUAL WIRES SUSPECTED OF BEING OPEN USING AN OHMMETER. IDENTIFY WIRE ENDS BY THE MARKERS.
- CHECK CONNECTORS (22 AND 23) FOR LOOSE OR BROKEN PINS.
- 3. CHECK GROMMETS (26 and 27) FOR TEARS OR DETERIORATION.
- CHECK TERMINALS AND SINGLE CONNECTORS FOR POOR JOINTS WITH WIRE, OR OTHER DEFECTS.

#### **INSTALLATION'**

#### NOTE

Connect all electrical leads as tagged during removal.

- SECURE REAR WIRE HARNESS SECTION(30)
  WITH EIGHT CABLE CLAMPS (17), SIX NUTS (11),
  SIX NEW LOCKWASHERS (12), FOUR NEW
  LOCKWASHERS (13), AND TWO FLATWASHERS
  (16). INSTALL GROMMET (27).
- 2. INSERT R.H. ADJUSTABLE LIGHT WIRE TERMINAL (29) THROUGH CAB WALL. CONNECT TERMINAL (29) TO R.H. ADJUSTABLE LIGHT.

- 3. CONNECT REMAINING SIX TERMINALS (29) TODEVICES INDICATED.
- 4. CONNECT CONNECTORS (22, 23, 24 AND 25) TO ORIGINAL LOCATIONS. INSTALL CABLE CLAMPS (19, 20, AND 21).
- 5. INSTALL TWO GROMMETS (26) AND GROMMET (27) TO FRONT HARNESS SECTION (28).
- 6. CONNECT ELEVEN CONNECTORS (9),
  THIRTY-FOUR CONNECTORS (8), SIX
  CONNECTORS (7), CONNECTORS (6),
  TWENTY-SEVEN CONNECTORS (5) AND
  EIGHTEEN CONNECTORS (4) TO DEVICES
  INDICATED.
- 7. SECURE LEADS TO HEATER STUD WITH FLATWASHER (16), NEW LOCKWASHER AND NUT (14).
- 8. SECURE LEADS TO TWO GROUND STUDS UNDER INSTRUMENT PANEL WITH NUTS (11), NEW LOCKWASHERS (13), FLATWASHERS (16), AND NEW LOCKWASHERS (18).
- 9. CONNECT FORTY-FOUR FEMALE CONNECTORS TO MALE CONNECTORS (1).
- 10. INSERT L.H. ADJUSTABLE LIGHT CONNECTOR (2) THROUGH HOLE IN CAB WALL AND PLUG INTO L.H. ADJUSTABLE LIGHT. INSTALL GROMMET (26) AND FOUR CABLE CLAMPS (17).
- 11. CONNECT NEGATIVE BATTERY CABLE, TM10-3930-660-20.

#### 6-8. MAIN WIRING HARNESS - REPLACE

This task covers:

- a. Removal
- b. Installation

**Initial Setup** 

Tools

Materials/Parts
Lockwashers (13, 17)

Tool Kit, Auto Mechanics

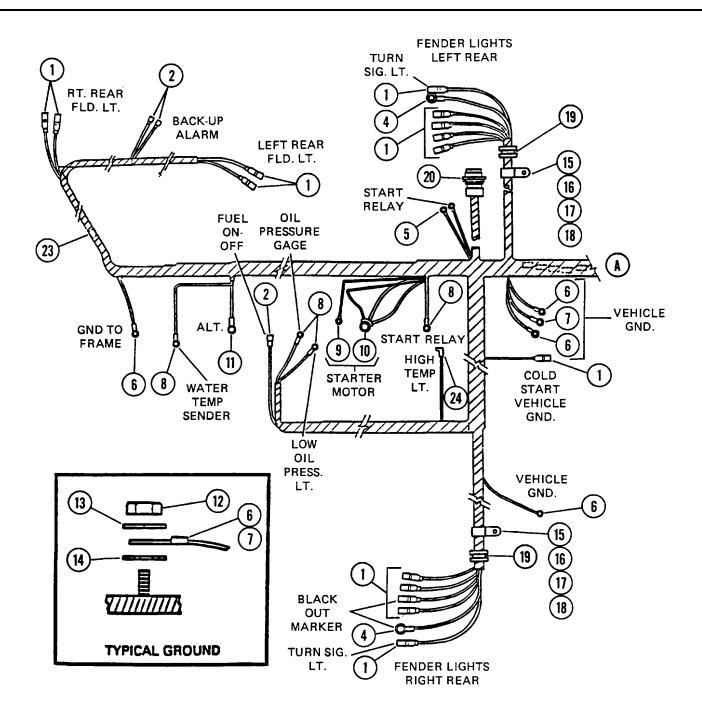
# **Equipment Condition**

Negative battery cable disconnected, TM10-3939-660-20.

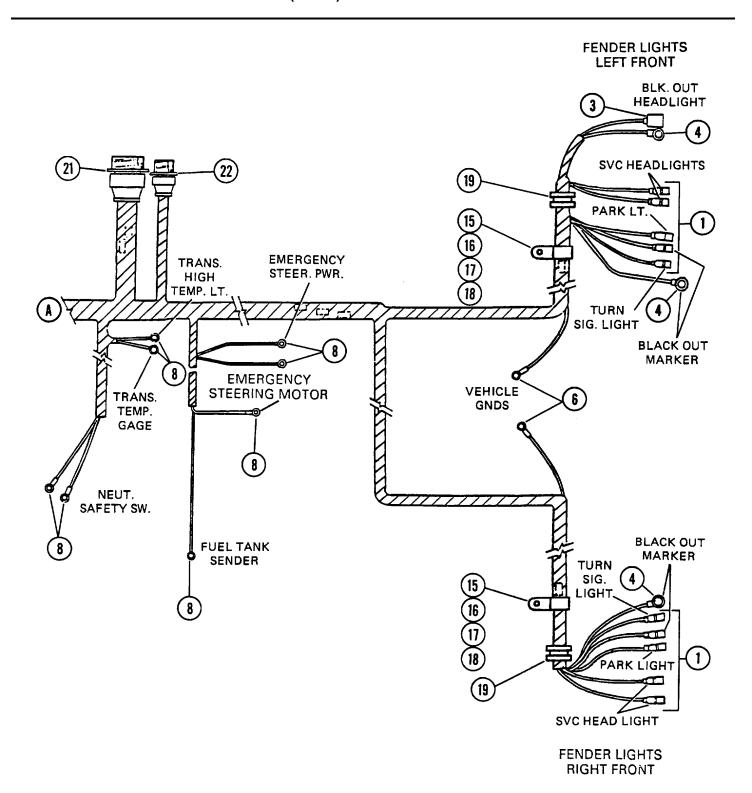
#### **REMOVAL**

- 1. UNPLUG 25 MALE CONNECTORS (1), THREE SPADE TERMINALS (2) AND FEMALE RECEPTACLE (3) FROM DEVICES INDICATED.
- 2. DISCONNECT FOUR TERMINAL RINGS (4), TWO TERMINAL RINGS (5), EIGHT TERMINAL RINGS (6), TERMINAL RING 7), TWELVE TERMINAL RINGS (8), TERMINAL RING (9), TERMINAL RING (10), TERMINAL RING (24), AND TERMINAL RING (11) FROM DEVICES INDICATED.
- 3. TO DISCONNECT GROUND TERMINAL RINGS (6 AND 7), REMOVE FIVE NUTS (12), FIVE LOCKWASHERS (13) AND FIVE FLATWASHERS (14). DISCARD LOCKWASHERS (13).
- 4. REMOVE FOUR CAPSCREWS (15), NUTS (16), LOCKWASHERS (17) AND CABLE CLAMPS (18). DISCARD LOCKWASHERS (17).
- 5. CAREFULLY PUSH OUT FOUR GROMMETS 19).
- 6. DISCONNECT CONNECTORS (20, 21 AND22).
- 7. REMOVE MAIN WIRING HARNESS (23).

# 6-8. MAIN WIRING HARNESS - REPLACE (Cont'd)



# 6-8. MAIN WIRING HARNESS - REPLACE (Cont'd)



6-31

# 6-8. MAIN WIRING HAESS - REPLACE (Cont'd)

# **INSTALLATION**

- 1. SECURE MAIN WIRE HARNESS (23) WITH FOUR CABLE CLAMPS (18), FOUR NEW LOCKWASHERS (17), FOUR NUTS (16) AND FOUR CAPSCREWS (15).
- 2. INSERT WIRE HARNESS BRANCHES THROUGH HOLES IN FRAME AND INSTALL FOUR GROMMETS (19).
- 3. CONNECT CONNECTORS (20, 21 AND 22) TO ORIGINAL LOCATIONS.
- 4. CONNECT GROUND TERMINAL RINGS (6 AND 7), INSTALL FIVE NUTS (12), FIVE NEW LOCKWASHERS (13) AND FIVE FLATWASHERS (14).
- 5. CONNECT FOUR TERMINAL RINGS (4), TWO TERMINAL RINGS (5), EIGHT TERMINAL RINGS (6), TERMINAL RING (7), TWELVE TERMINAL RINGS (8), TERMINAL RING (9), TERMINAL RING(10), TERMINAL RING (11) AND TERMINAL RING (24) TO DEVICES INDICATED.
- 6. PLUG IN 25 MALE CONNECTORS (1), THREE SPADE TERMINALS (2) AND FEMALE RECEPTACLE (3) TO DEVICES INDICATED.
- 7. CONNECT NEGATIVE BATTERY CABLE, TM10-3930-660-20.

#### 6-9. ELECTRIC JOYSTICK ASSEMBLY - REPAIR/TEST/ADJUST

#### This task covers:

- a. Removal of microswitches
- b. Removal of handle pushbutton switch
- c. Inspection
- d. Installation of handle pushbutton switch
- e. Installation of microswitches
- f. Testing and adjustment of joystick "threshold" and "max out" settings.

#### Initial Setup

**Tools** 

Tool Kit, General Mechanics

Materials/Parts

Bowed Washers (12)

**Test Equipment** 

Ammeter

Reference

TM10-3930-660-10 TM10-3930-660-20.

# **Equipment Condition**

Electric joystick removed, TM10-3930-660-20

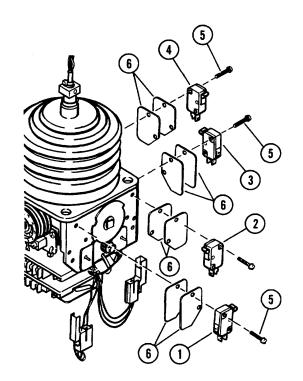
# **REMOVAL OF MICROSWITCHES**

REMOVE MICROSWITCHES (1) THROUGH (4).

- a. Disconnect plug from microswitch (1).
- b. Remove two screws (5), microswitch (1), and two spacers (6).
- c. Repeat steps a and b for microswitches (2), (3), and (4).

#### **REMOVAL OF HANDLE PUSHBUTTON SWITCH**

- 1. REMOVE PARTS (8) THROUGH (13) AND PARTS (15) THROUGH (18) FROM HANDLE SECTIONS (7).
- a. Pull off boot (8) from handle sections (7).
- b. Remove two screws (9) and two nuts (10) at top of handle sections (7).
- c. Remove two screws (11), two bowed washers (12) and two nuts (13) at bottom of handle sections (7). Discard bowed washers (12).



# 6-9. ELECTRIC JOYSTICK ASSEMBLY - REPAIR/TEST/ADJUST (Cont'd)

- d. Separate handle sections (7) and remove them from shaft coupling (14).
- e. Remove actuating button (15).
- f. Remove pushbutton switch (16) nut (17) and flange (18) as a unit from handle sections (7).
- 2. UNSOLDER FOUR LEADS FROM PUSHBUTTON SWITCH (16) AND DISASSEMBLE PARTS (17) THROUGH (19).
  - a. Carefully unsolder all leads from pushbutton switch (16).
  - b. Remove nut (17) and flange (18) rom pushbutton switch (16).
  - c. Remove cover (19) from pushbutton switch (16).



1. CHECK FOR LOOSE OR DISCONNECTED PLUGS AT SWITCHES (1) THROUGH (4).

2 . CHECK ALL SWITCHES FOR LOOSE MOUNTING HARDWARE OR VISIBLE DAMAGE.

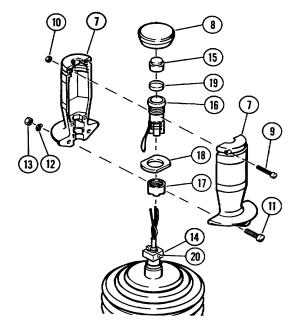
#### **INSTALLATION OF HANDLE PUSHBUTTON SWITCH**

- 1. ASSEMBLE PARTS (17) THROUGH (19) AND SOLDER FOUR LEADS TO PUSHBUTTONSWITCH (16)
  - a. Install cover (19) to pushbutton switch.
  - b. Install flange (18) and nut (17) to pushbutton switch (16).

#### **NOTE**

Pin numbers are printed on body of pushbutton switch (16).

 Solder green electrical lead of joystick to pin 1 of pushbutton switch (16).



# 6-9. ELECTRIC JOYSTICK ASSEMBLY - REPAIR/TEST/ADTUST (Cont'd)

- d. Solder yellow electrical lead of joystick to pin 2 of pushbutton switch (16)
- e. Solder green jumper lead to pin 1 and pin 3 of pushbutton switch (16).
- f. Solder red electrical lead of joystick to pin 4 of pushbutton switch (16)
- 2. INSTALL PARTS (8) THROUGH (13) AND PARTS (15) THROUGH (18) TO HANDLE SECTIONS (7).

# **NOTE**

Align handle section (7) on shaft coupling (14) so that coupling set screw (20) is facing center of handle section (7).

a. Place one handle section (7) on shaft coupling (14).

Place switch flange (18) in lowest slot with flat surface of flange facing center of handle section (7).

- b. Install pushbutton switch (16), flange (18), and nut (17) as a unit to handle section (7).
- c. Install actuating button (15) with smaller diameter of button extending through top of handle section (7).
- d. Place other handle section (7) on shaft coupling (14).
- e. Install two screws (11), two new bowed washers (12) and two nuts (13) at bottom of handle sections (7).

# 6-9. ELECTRIC JOYSTICK ASSEMBLY - REPAIR/TEST/ADJUST (Cont'd)

- f. Install two screws (9) and two nuts (10) at top of handle sections (7).
- g. Place boot (8) on handle sections (7).

#### **INSTALLATION OF KICROSWITCHES**

#### **NOTE**

Plug with red and black leads from upper circuit board (21) connects to microswitch (1).

Plug with white, blue, and yellow leads from upper circuit board (21) connects to microswitch (2).

Plug with red and black leads from lower circuit board (22) connects to microswitch (3).

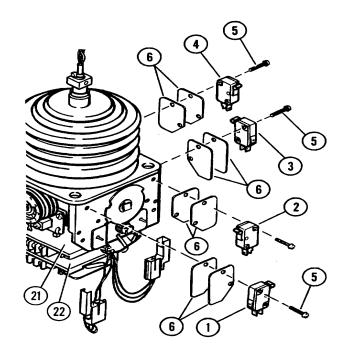
Plug with white, blue, and yellow leads from upper circuit board (22) connects to microswitch (4).

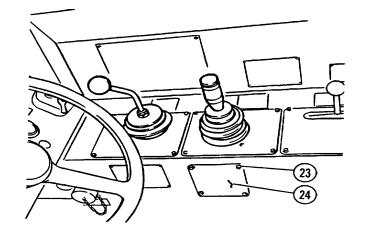
# **INSTALL MICROSWITCHES (1) THROUGH (4).**

- a. Secure microswitch (1) and two spacers (6) with two screws (5).
- b. Connect plug to microswitch (1)
- c. Repeat steps a and b for microswitches (2) through (4).

# TESTING AND ADJUSTMENT OF JOYSTICK "THRESHOLD" AND "MAX OUTS" SETTINGS

- 1. INSTALL ELECTRIC JOYSTICK, TM10-3930-660-20.
- 2. REMOVE FOUR CAPSCREWS (23) AND PLATE (24).





# 6-9. ELECTRIC JOYSTICK ASSEMBLY - REPAIR/TEST/ADJUST (Cont'd)

- 3. MEASURE CURRENT FLOW TO UPPER CIRCUITBOARD (21). IF NECESSARY, ADJUST"THRESHOLD" AND "MAX OUT" CONTROLS.
  - a. Loosen screw (25) at terminal A of upper circuit board (21) and disconnect electrical lead %53.
  - b. Connect positive (+) lead of suitable ammeter to terminal A of upper circuit board (21).
  - c. Connect negative (-) lead of ammeter to disconnected electrical lead %53.
  - d. Turn starter switch to the RUN position but do not start the engine, TM10-3930-660-10.
  - e. Slowly move joystick handle (7) to the left until indicator light (26) just comes on. Ammeter reading should be between 300 and 340 ma.

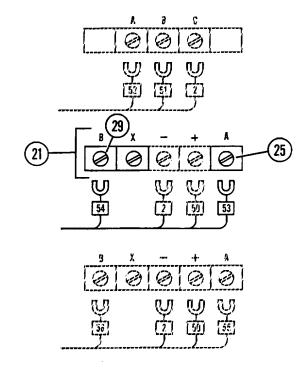
#### **NOTE**

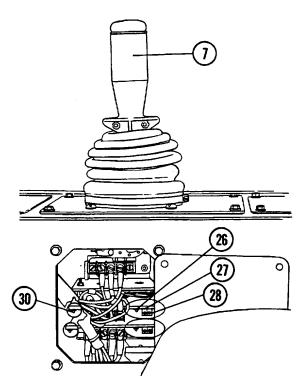
During step f., Turn "threshold" control (27) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

- f. If reading in step e. was not within limits of 300 to 340 ma., adjust "threshold" control (27) and repeat step e until ammeter reads approximately 320 ma.
- g. Move joystick handle (7) fully to the left and observe ammeter reading. Reading should be between 600 and 640 ma.

#### **NOTE**

During step h., turn "max out" control (28) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.





- h. If reading in step g. was not within limits of 600 to 640 ma., adjust "max out" control (28) and repeat step g. until ammeter reads approximately 620 ma.
- i. Turn starter switch off, TM10-3930-660-10.
- j. Disconnect leads of ammeter. Secure electrical lead #53 to terminal A of top circuit board (21) with screw (25).
- k. Loosen screw (29) at terminal B of top circuit board (21) and disconnect electrical lead #54.
- I. Connect positive (+) lead of suitable ammeter to terminal B o top circuit board (21).
- m. Connect negative (-) lead of ammeter to disconnected electrical lead %54.
- n. Turn starter switch to the RUN position but do not start the engine, TM10-3930-660-10.
- o. Slowly move joystick handle (7) to the right until indicator light (30) just comes on. Ammeter reading should be between 300 and 340 ma.

#### **NOTE**

During step p., Turn "threshold" control (27) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

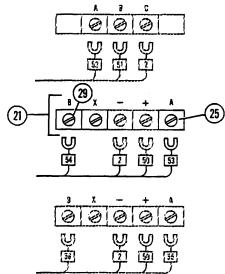
p. If reading in step o. was not within limits of 300 to 340 ma., adjust "threshold" control (27) and repeat step o. until ammeter reads approximately 320 ma.

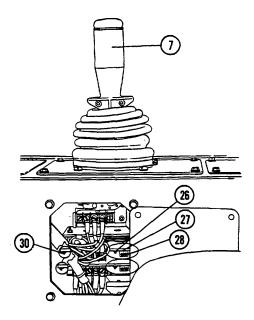
q. Move joystick handle (7) fully to the right and observe ammeter reading. Reading should be between 600 and 640 ma.

### **NOTE**

During step r., turn "max out" control (28) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

- r. If reading in step q. was not within limits of 600 to 640 ma., adjust "max out" control (28) and repeat step q. until ammeter reads approximately 620 ma.
- s. Turn starter switch off, TM10-3930-660-10.
- t. Disconnect leads of ammeter. Secure electrical lead #54 to terminal B of top circuit board (21) with screw (29).
- Repeat steps 3a through 3j and check that current readings are still within limits. Readjust "threshold" (27) and "max out" (28) controls as required.
- 4. MEASURE CURRENT FLOW TO LOWER CIRCUIT BOARD (22). IF NECESSARY, ADJUST "THRESHOLD" AND "MAX OUT" CONTROLS.
  - a. Connect joystick to cab wiring harness (1).
  - b. Loosen screw (31) at terminal A of bottom circuit board (22) and disconnect electrical lead #55.
  - c. Connect positive (+) lead of suitable ammeter to terminal A of bottom circuit board (22).
  - d. Connect negative (-) lead of ammeter to disconnected electrical lead #55.





- e. Turn starter switch to the RUN position but do not start the engine, TM10-3930-660-10.
- f. Slowly move joystick handle (7) rearward until indicator light (32) just comes on. Ammeter reading should be between 300 and 340 ma.

#### NOTE

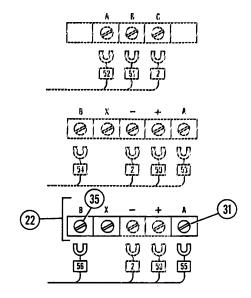
During step g., Turn "threshold" control (33) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

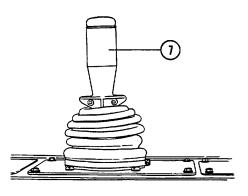
- g. If reading in step f. was not within limits of 300 to 340 ma., adjust "threshold" control (33) and repeat step f until ammeter reads approximately 320 ma.
- h. Move joystick handle (3) fully rearward and observe ammeter reading. Reading should be between 600 and 640 ma.

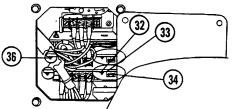
### NOTE

During step i., turn "max out" (34) control counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

- i. If reading in step h. was not within limits of 600 to 640 ma., adjust "max out" control (34) and repeat step h until ammeter reads approximately 620 ma.
- j. Turn starter switch off, TM10-3930-660-10.
- k. Disconnect leads of ammeter. Secure electrical lead #55 to terminal A of bottom circuit board (22) with screw (31).







- I. Loosen screw (35) at terminal B of bottom circuit board (22) and disconnect electrical lead #56.
- m. Connect positive (+) lead of suitable ammeter to terminal B of bottom circuit board (22).
- n. Connect negative (-) lead of ammeter to disconnected electrical lead #56.
- o. Turn starter switch to the RUN position but do not start the engine, TM10-3930-660-10.
- p. Move joystick handle (7) forward until indicator light (36) just comes on. Ammeter reading should be between 300 and 340 ma.

#### NOTE

During step q., Turn "threshold" control (33) counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

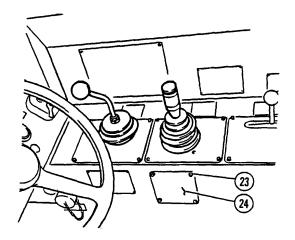
- q. If reading in step p. was not within limits of 300 to 340 ma., adjust "threshold" control (33) and repeat step f until ammeter reads approximately 320 ma.
- r. Move joystick handle (7) fully forward and observe ammeter reading. Reading should be between 600 and 640 ma.

#### NOTE

During step s., turn "max out" (34) control counterclockwise to lower ammeter reading, and clockwise to raise ammeter reading.

s. If reading in step r. was not within limits of 600 to 640 ma., adjust "max out" control (34) and repeat step h until ammeter reads approximately 620 ma.

- t. Turn starter switch off, TM10-3930-660-10.
- k. Disconnect leads of ammeter. Secure electrical lead #56 to terminal B of bottom circuit board (22) with screw (35).
- Repeat steps 4a through 4k and check that current readings are still within limits. Readjust "threshold" (33) and "max out" (34) controls as required.
- 5. SECURE PLATE (24) WITH FOUR CAPSCREWS (23).



#### **CHAPTER 7**

#### TRANSMISSION NAINTENANCE

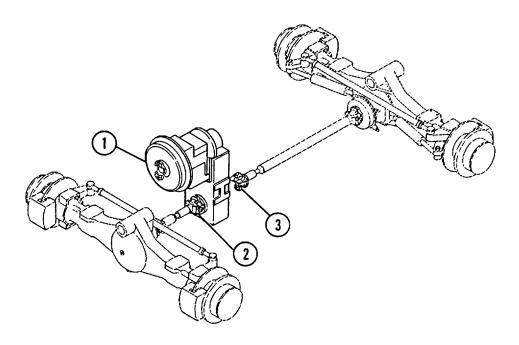
#### Section I. DESCRIPTION AND DATA

### 7-1. GENERAL.

This chapter covers maintenance procedures for the transmission, as well as principles of operation.

#### 7-2. PRINCIPLES OF OPERATION.

- a. <u>General</u>. The transmission has four forward and four reverse speeds, with speed and direction controlled by hydraulic operated clutches. Engine torque is coupled to the transmission through the torque converter (1).
- b. <u>Torque Converter</u>. The torque converter (1) couples engine torque to the transmission input shaft. It is basically a fluid drive, which has no mechanical connection through it. This feature not only eliminates nearly all wear, but also provides a smooth and almost shock-free drive which prevents engine stalling and lugging. Under light loads, engine speed is transmitted at almost a 1:1 ratio through the torque converter. As loads increase, however, the torque converter inherently multiplies engine torque. The need to manually shift transmission gears is therefore greatly reduced, but not totally eliminated.
- c. Clutches. The clutches are hydraulically applied and spring released. Using hydraulic power to control clutch application permits automatic compensation for clutch wear; therefore, there is no need for clutch adjustment. Each clutch contains a number of paper graphitic friction plates and polished steel reaction plates. Clutch actuation determines speed and direction of rotation of output shafts (2 and 3), which transmit power to the respective axle differentials.



# Section II. TRANSMISSION MAINTENACE PROCOURES

# TRANSMISSION MAINTENANCE TASK SUMARY

TASK		PAGE
PARA.	PROCEDURES	NO.
7-3	Torque Converter - Replace/Repair	7-3
7-4	Transmission Assembly - Replace/Repair	7-8
7-5	Transmission Front Cover Assembly - Replace/Repair	7-37
7-6	Transmission Output Shaft - Replace/Repair/Adjust	7-44
7-7	Transmission Input Shaft - Replace/Repair	7-47
7-8	Transmission Control Valve - Replace/Repair	7-49
7-9	Transmission Oil Pump - Replace/Repair	7-54

#### 7-3. TORQUE CONVERTER - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# **INITIAL SETUP:**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

### **Equipment Condition**

Transmission driveshaft removed, para. 7-6.

#### Materials/Parts

Hydraulic Oil (App. B, Item 35) Lint-Free Rags (App. B, Item 38) Lockwashers (14) Loctite P222 (App. B, Item 40) Loctite #262 (App. B, Item 42) O-ring (25, 43)

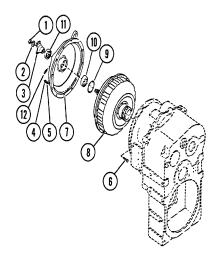
### **REMOVAL**

- 1. REMOVE NUT (1), WASHER (2) AND YOKE (3).
- 2. REMOVE TWELVE HEX NUTS (4), TWELVE STARWASHERS (5) AND TWELVE CAPSCREWS (6).
- 3. REMOVE TORQUE CONVERTER COVER (7).
- 4. REMOVE TORQUE CONVERTER ASSEMBLY (8) AND PLACE ON A CLEAN WORKBENCH WITH FRONT COVER FACING UP.

### **DISASSEMBLY**

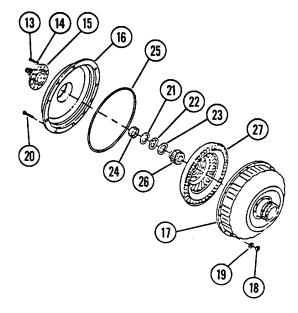
1. REMOVE PARTS (9-12) FROM TORQUE CONVERTER COVER (7).

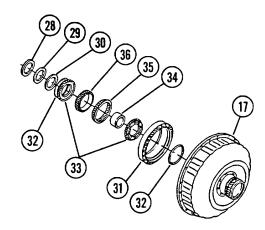
Remove snap ring (9), bearing (10) and oil seal (11).



# 7-3. TORQE CONVERTER - REPLACE/REPAIR (Cont'd)

- 2. REMOVE PARTS (13-15), FRONT COVER (16), PARTS (17-26) AND TURBINE (27).
  - a. Remove twelve capscrews (13), twelve lockwashers (14) and converter input shaft (15). Discard lockwashers (14).
  - Mark front cover (16) and impeller (17) for assembly.
     Remove twenty hex nuts (18), twenty flatwashers (19), twenty
     capscrews (20) and front cover (16).
  - c. Remove outer thrust race (21), needle thrust bearing (22) and inner thrust race (23).
  - d. Use a suitable puller tool and remove bearing (24).
  - e. Remove and discard O-ring (25) from front cover (16).
  - f. Remove turbine hub (26) and turbine (27).
- 3. REMOVE PARTS (28-30), STATOR (31) AND DISASSEMBLE PARTS (32-36).
  - Remove outer thrust washer (28), needle thrust bearing (29), inner thrust washer (30) and stator (31) from impeller (17).
  - b. Remove two retaining rings (32), two clutch retainers (33), inner race (34), sprag clutch assembly (35) and outer race (36).





# 7-3. TORQUE CONVKRTER - REPLACE/REPAIR (Cont'd)

- 4. REMOVE PARTS (37-39), IMPELLER HUB (42) AND PARTS (43 AND 44).
  - a. Remove outer thrust washer (37), needle thrust bearing (38) and inner thrust washer (39).
  - b. Remove eight capscrews (40), eight flatwashers (41) and impeller hub (42) from impeller (17).
  - c. Remove O-ring (43) and seal ring (44). Discard O-ring (43).

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

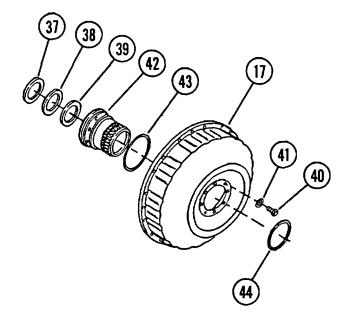
See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

**NOTE** 

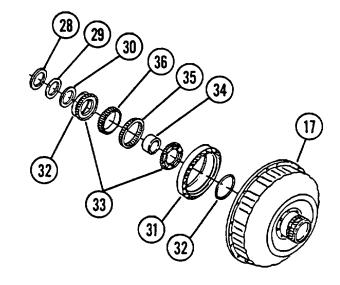
Wipe all sealing surfaces clean and dry. Apply a thin film of clean hydraulic oil to all seals and bearings as they are installed.

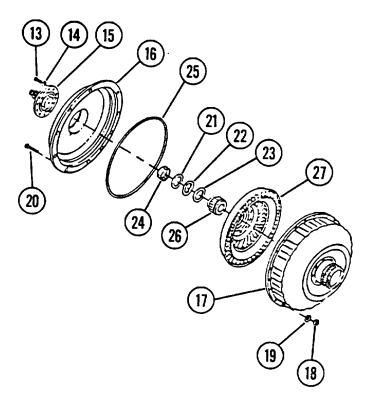
- 1. INSTALL PARTS (43 AND 44), IMPELLER HUB (42) AND PARTS (37-39).
  - Install new O-ring (43) at base of impeller hub (42).
  - b. Install seal ring (44) on impeller hub (42).
  - c. Install impeller hub (42), eight capscrews (40) and eight flatwashers (41). Torque capscrews (40) to 25 lb. ft.
  - d. Install inner thrust washer (39), needle thrust bearing (38) and outer thrust washer (37).



# 7-3. TORQUE CONVERTER - REPLACE/REPAIR (Cont'd)

- 2. ASSEMBLE PARTS (32-36), INSTALL STATOR (31) AND PARTS (28-30).
  - a. Install outer race (36), sprag clutch assembly (35) and inner race (34). Clutch assembly flange should be toward front of converter as shown. Stator will freewheel counterclockwise viewed from output end.
  - Install sprag clutch assembly (35) with flanged edge of cage toward side of stator (31) marked "FRONT" or the letter "F". The stator (31) will free-wheel counterclockwise when viewed from output side.
  - c. Install two clutch retainers (33) and two retaining rings (32).
  - d. Install stator (31) in impeller (17) so that the word "FRONT" faces away from impeller.
  - e. Install inner thrust washer (30), needle thrust bearing (29) and outer thrust washer (28).
- 3. INSTALL TURBINE (27), PARTS (23-26), FRONT COVER (16) AND PARTS (13-17).
  - a. Install turbine (27) and turbine hub (26).
  - b. Install inner thrust race (23), needle thrust bearing (22) and outer thrust race (21).
  - c. Install bearing (24) 0.040 inch below thrust race (21) surface.



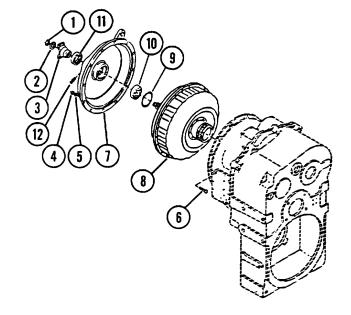


# 7-3. TORQUE CORTBR - REPLACE/REPAIR (Cont'd)

- d. Install new O-ring (25) on front cover (16).
- e. Align marks made at disassembly between front cover (16) and impeller (17). Install front cover (16).
- f. Apply Loctite #222 to threads of capscrews (20). Install twenty capscrews (20), twenty flatwashers (19) and twenty hex nuts (18). Torque capscrews (20) to 25 lb. ft.
- g. Install converter input shaft (15). Apply Loctite #262 to threads of capscrews (13). Install twelve new lockwashers (14) and twelve capscrews (13). Torque capscrews (13) to 30 lb. ft.
- 4. INSTALL PARTS (9-12) IN FRONT HOUSING (7).
  - If removal was necessary, install grease fitting (12).
  - b. Install oil seal (11), bearing (10) and snap ring (9).

#### **INSTALLATION**

- 1. INSTALL TORQUE CONVERTER ASSEMBLY(8) IN TRANSMISSION HOUSING.
- 2. INSTALL FRONT HOUSING (7), TWELVE CAPSCREWS (6), TWELVE STARWASHERS (5) AND TWELVE HEX NUTS (4).
- 3. INSTALL YOKE (3), WASHER (2) AND NUT (1). TORQUE NUT (1) TO 300-350 LB. FT.
- 4. INSTALL TRANSMISSION OUTPUT SHAFT, PARA. 7-6.



#### This task covers:

- a. Removal
- b. Disassembly
- c. Inspection
- d. Reassembly
- f. Installation
- e. Pre-Load Check of Bearing

### **INITIAL SETUP:**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

Tool Kit, Transmission consisting of the following: Lift, Clutch Pack Two Bearing Drivers Spring Compressor Tool

Lifting Device, Capacity 5 ton

Fabricated Tools - Transmission
Alignment Bars (App. C, Fig. C-6)

Cap and Plug Set

#### **Equipment Condition**

Transmission oil drained, LO10-3930-660-12. Transmission cover removed, TM10-3930-660-20.

# Materials/Parts

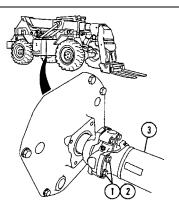
Cotter Pin (11)
Gasket (115)
Grease (App. B, Item 11)
Lockwashers (2, 5, 9, 23, 27, 37)
Loctite #242 (App. B, Item 41)
Oil Pan
O-ring (25, 29, 64, 85, 102)
Seal (65, 86, 103)
Tags (App. B, Item 52)
Tie Wrap (19)
Transmission Oil (App. B, Item 35)
Wood Blocks

### Personnel Required

Two Personnel

### **REMOVAL**

- 1. RAISE BOOM TO MAXIMUM HEIGHT. USE A HOIST WITH SLING OR OTHER SUITABLE DEVICE TO SUPPORT BOOM.
- 2. DISCONNECT SHAFTS (3 AND 6) FROM TRANSMISSION.
  - a. Remove four capscrews (1), four lockwashers (2) and disconnect front propeller shaft (3). Discard lockwashers (2). Carefully lower front propeller shaft (3) to ground.



b. Remove four capscrews (4), four lockwashers (5) and disconnect rear propeller shaft (6). Discard lockwashers (5).

3.

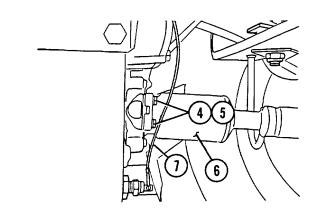
- TAG AND DISCONNECT LEAD (7) FROM TRANSMISSION TEMPERATURE SWITCH.
- REMOVE FOUR 4. **CAPSCREWS** (8).**FOUR LOCKWASHERS** (9)AND DISCONNECT TRANSMISSION **PROPELLER SHAFT** (10).DISCARD LOCKWASHERS (9). SLIDE YOKE OF SHAFT (10) TOWARD ENGINE TO PROVIDE CLEARANCE.
- 5. DISCONNECT TRANSMISSION CABLES (13 AND 14) FROM TRANSMISSION CONTROL VALVE.
  - a. Remove cotter pin (11) and washer (12) from each transmission cable (13 and 14) at transmission control valve. Discard cotter pins (11).
- b. Remove four nuts (15) securing clamps for transmission cables (13 and 14).
- Disconnect transmission cables (13 and 14) from transmission control valve. Tag the cables for installation.

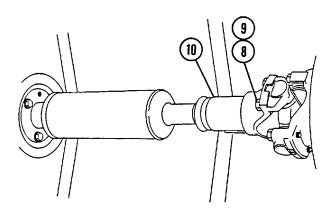
### **CAUTION**

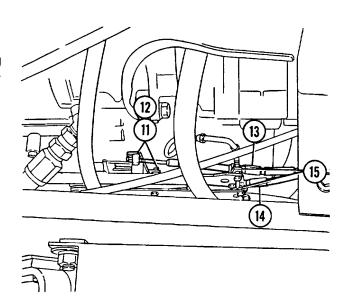
Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

## **NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.

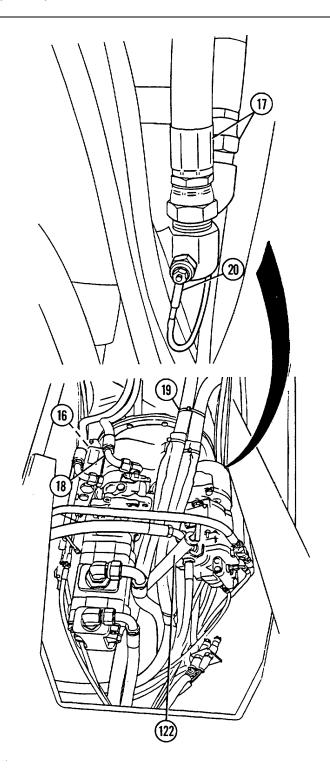




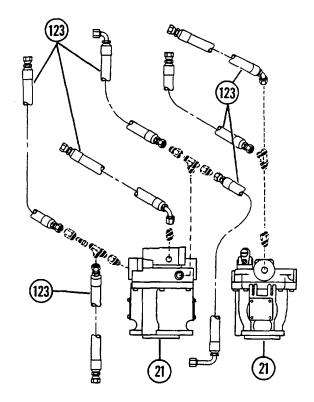


# 6.TAG AND DISCONNECT HOSES (16-18).

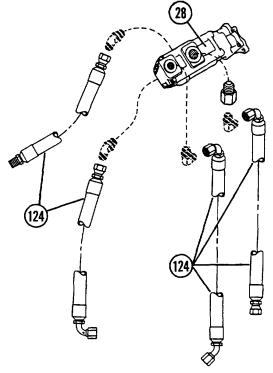
- a. Tag and disconnect transmission disconnect valve hose (16) from transmission control valve. Cap or plug fitting.
- b. Tag and disconnect two transmission oil cooler hoses (17) from transmission.
- c. Tag and disconnect two transmission oil filter hoses (18) from transmission.
- 7. CUT AND DISCARD TIE WRAP (19) FROM UPPER HYDRAULIC HOSES THAT CONNECT HYDRAULIC CONTROL VALVE TO TRANSMISSION AND HYDRAULIC PUMPS.
- 8. TAG AND DISCONNECT LEAD (20) FROM TRANSMISSION TEMPERATURE SENDER.
- 9. REMOVE TRANSMISSION OIL FILLER TUBE (122).



10. TAG AND DISCONNECT SEVEN HYDRAULIC HOSES (123) AT PISTON PUMP (21).



11. TAG AND DISCONNECT FOUR HYDRAULIC HOSES (124) AT TANDEM GEAR PUMP (28).



- 12. TAG AND DISCONNECT HOSE (30) AT MAIN CONTROL VALVE ASSEMBLY. MOVE ALL OTHER HOSES TO EITHER SIDE OF TRANSMISSION TO PROVIDE CLEARANCE.
- 13. TAG AND DISCONNECT TWO LEADS FROM NEUTRAL SAFETY SWITCH (31).
- 14. REMOVE PARTS (32-37, 40-42) AND RIGHT FRONT TRANSMISSION MOUNTING BRACKET (38).
  - a. Remove two hex head capscrews (32), two nuts (33), two rebound washers (34) and two rubber mounts (35).

### **NOTE**

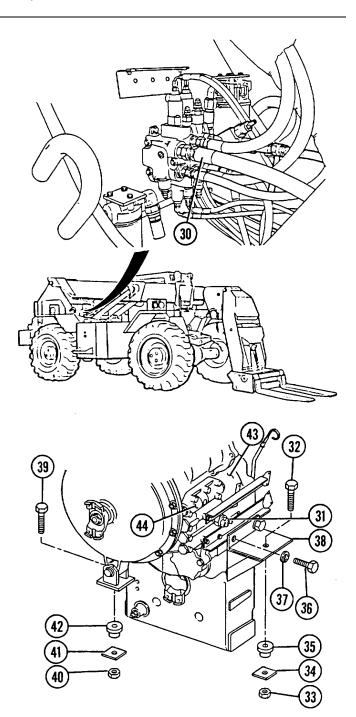
Weight of transmission approximately 950 lbs.

- Use a hoist with slings or other suitable lifting device to support transmission. Place slings under input yoke and output yokes. Secure slings together.
- Remove four hex head capscrews (36), four lockwashers (37) and right front transmission mounting bracket (38). Discard lockwashers (37).

### **NOTE**

Place a drift and wedge between capscrew (39) and side of rear transmission mount to prevent capscrew (39) from moving when removing nut (40).

- d. Remove nut (40), rebound washer(41) and rubber mount (42) from rear transmission mount.
- 15. REMOVE TRANSMISSION (43).
  - a. Use hoist to slowly lift transmission (43) until it clears vehicle frame. Ensure that hoses and other obstructions are clear of transmission during removal.



- b. Lift transmission forward and to the side so it clears boom lift cylinders.
- 16. REMOVE PISTON PUMP (21) FROM TRANSMISSION.
  - Support piston pump (21) and remove two hex head capscrews (22), two lockwashers (23), two flatwashers (24) and piston pump (21).
     Discard lockwashers (23).
  - b. Remove and discard O-ring (25) from hydraulic piston pump drive adapter.
- 17. REMOVE TANDEM GEAR PUMP (28) FROM TRANSMISSION.
  - Remove two hex head capscrews (26), two lockwashers (27) and tandem gear pump (28).
     Discard lockwashers (27).
  - b. Remove and discard O-ring (29) from hydraulic gear pump drive.

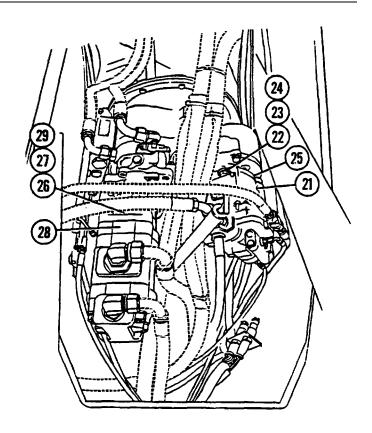
### **DISASSEMBLY**

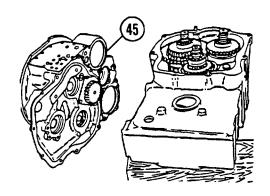
- 1. REMOVE TRANSMISSION CONTROL VALVE (44), PARA. 7-8.
- 2. REMOVE FRONT COVER ASSEMBLY (45), PARA. 7-5.

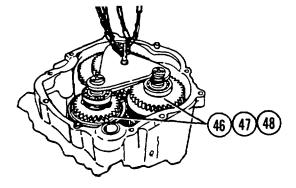
# NOTE

All three clutch packs must be removed together because of gear meshing.

- 3. REMOVE CLUTCH PACKS (46-48).
  - Install a special lifting tool in bottom groove of all three shafts.
  - b. Attach a hoist with slings to special lifting tool and remove clutch packs (46-48).







- c. Place clutch packs (46-48) on a clean bench. Place a wood block under first stage clutch pack. Remove special lifting tool from clutch packs.
- 4. SEPARATE THREE CLUTCH PACKS (46-48).
- 5. DISASSEMBLE FIRST STAGE CLUTCH PACK (46).

### **CAUTION**

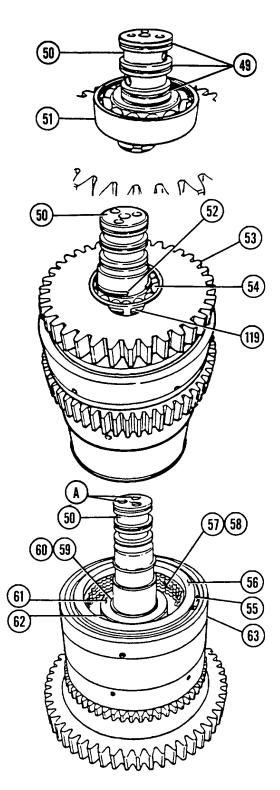
Use care when removing seal rings (49) to prevent clutch shaft damage.

- a. Remove three seal rings (49) from shaft assembly (50).
- b. Use two pry bars 1800 apart to pry bearing (51) up and remove it from shaft assembly (50).
- c. Remove snap ring (52) from shaft assembly (50).
- d. Use a gear puller to remove weld gear (53) and bearing (54) as an assembly from shaft assembly (50).
- e. Using an assistant to spread snap ring (119), use a driver to remove bearing (54) from weld gear (53).
- f. Remove snap ring (55).
- g. Slide retainer (56) out of shaft assembly (50).

### CAUTION

Carefully handle clutch plates (57) so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

h. Remove six clutch plates (57) and six separator plates 58).



### **NOTE**

The first stage clutch pack contains twelve clutch plates (57) and twelve separator plates (58).

### WARNING

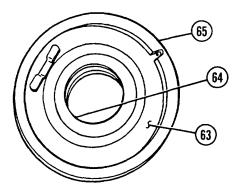
Springs (61) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

- i. Place shaft assembly (50) in a press. Install a clutch spring compressor tool.
- Press down on spring compressor tool and retainer (59) just enough to relieve pressure on retainer ring (60). Remove retainer ring (60). Slowly remove clutch spring compressor tool.
- k. Remove retainer (59), four springs (61) and thrust washer (62).

### **WARNING**

Do not exceed 30 psig nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

- I. Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (50). Use compressed air to remove piston (63).
- m. Remove and discard O-ring (64) and outer piston seal (65).

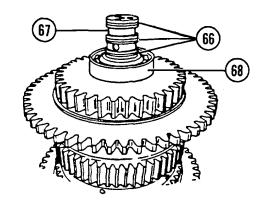


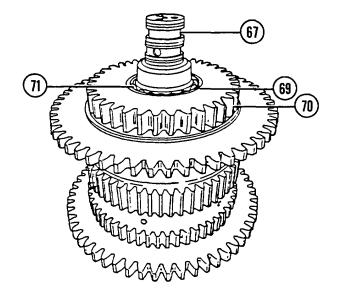
- n. Turn shaft assembly over (50) and repeat STEPS b m.
- 6. DISASSEMBLE SECOND STAGE CLUTCH PACK (47).

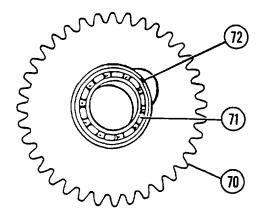
### **CAUTION**

Use care when removing seal rings (66) to prevent clutch shaft damage.

- a. Remove three seal rings (66) from shaft assembly (67).
- b. Use two pry bars 1800 apart to pry bearing (68) up and remove it from shaft assembly (67).
- c. Remove snap ring (69) from shaft assembly (67).
- d. Use a gear puller to remove weld gear (70) and bearing (71) as an assembly from shaft assembly (67).
- e. Using an assistant to spread snap ring (72), use a driver to remove bearing (71) from weld gear (70).
- f. Remove snap ring (120).
- g. If necessary remove snap ring (72) from weld gear (70).







h. Slide retainer (73) out of shaft assembly (67).

### **CAUTION**

Carefully handle clutch plates (74) so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

i. Remove six clutch plates (74) and six separator plates (75).

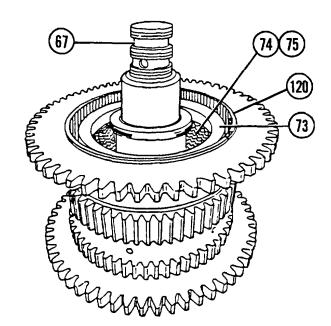
### **NOTE**

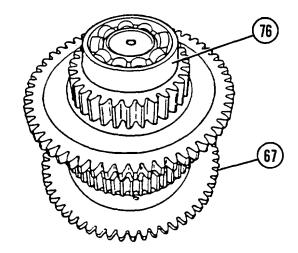
The second stage clutch pack contains twelve clutch plates (74) and twelve separator plates (75).

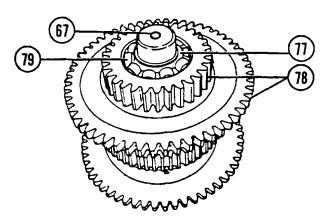
- j. Turn shaft assembly (67) over.
- k. Use two pry bars 1800 apart to pry bearing (76) up and remove it from shaft assembly (67).
- I. Remove snap ring (77).
- m. Use a gear puller to remove weld gear (78) and two bearings (79) as an assembly from shaft assembly (67).

# **WARNING**

Springs (82) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.





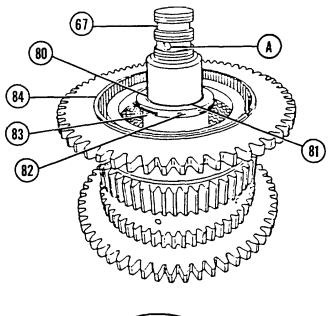


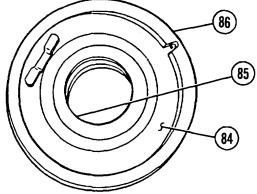
- n. Place shaft assembly (67) in a press.Install a clutch spring compressor tool.
- Press down on spring compressor tool and retainer (80) just enough to relieve pressure on retainer ring (81). Remove retainer ring (81). Slowly remove clutch spring compressor tool.
- p. Remove retainer (80), four springs (82) and thrust washer (83).

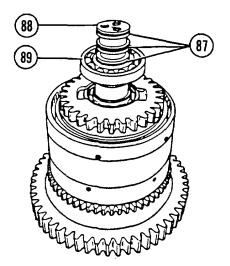
# WARNING

Do not exceed 15 psig nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

- q. Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (67). Use compressed air to remove piston (84).
- r. Remove and discard O-ring (85) and outer piston seal (86).
- s. Turn shaft assembly (67) over and repeat STEPS e, g, h and m-q.
- 7. DISASSEMBLE THIRD STAGE CLUTCH PACK (48).
  - a. Remove three seal rings (87) from shaft assembly (88).
  - b. Use two pry bars 1800 apart to pry bearing (89) up and remove it from shaft assembly (88).







- c. Remove two snap rings (90).
- d. Use a gear puller to remove weld gear (91) and bearing (92) as an assembly from shaft assembly (88).
- e. Using an assistant to spread snap ring (121), use a driver to remove bearing (92) from weld gear (91).
- f. Remove snap ring (93) and clutch plate retainer (94) from shaft assembly (88).
- g. Remove four clutch plates (95) and four separator plates (96).

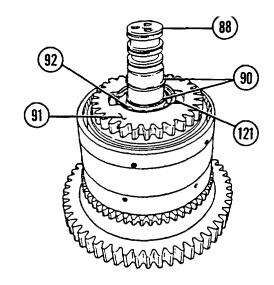
### **NOTE**

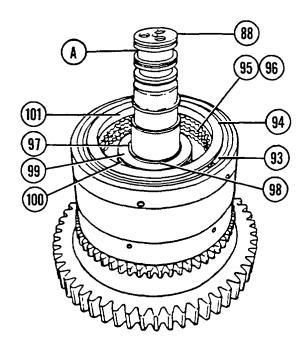
The third stage clutch pack contains four clutch plates (95) and four separator plates (96).

# WARNING

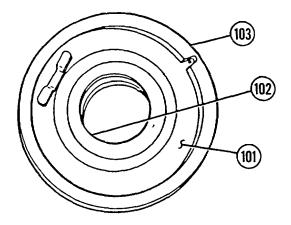
Springs (99) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

- h. Place shaft assembly (88) in a press. Install a clutch spring compressor tool.
- Press down on spring compressor tool and retainer (97) just enough to relieve pressure on retainer ring (98). Remove retainer ring (98). Slowly remove clutch spring compressor tool.
- j. Remove retainer (97), four springs (99) and thrust washer (100).

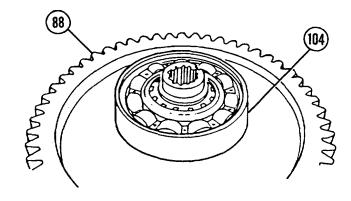




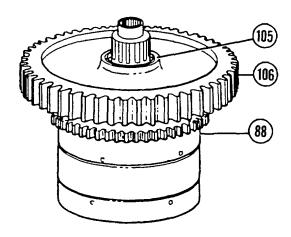
- k. Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (88). Use compressed air to remove piston (101).
- 1. Remove and discard O-ring (102) and outer piston seal (103).



m. Turn shaft assembly (88) over. Use a puller to remove bearing (104) from shaft assembly (88).



n. Remove snap ring (105) and gear (106) from shaft assembly (88).



- 8. REMOVE PARTS (107-111 AND 113-118) FROM TRANSMISSION CASE (112), IF NECESSARY.
  - a. Remove capscrew (107), clamp (108), dipstick (109), dipstick tube (110) and elbow (111), from transmission case (112).
  - b. Remove two locating bushings (113).
  - c. Remove suction screen (114) and gasket (115). Discard gasket (115).
  - d. Remove capscrew (116) from clamp (117) and remove suction tube (118).



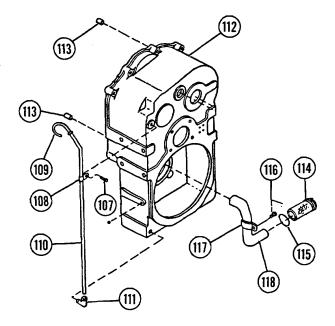
See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

- 1. INSTALL PARTS (107-111, 113-118) IN TRANSMISSION CASE (112).
  - a. Install suction tube (118) and secure with clamp (117) and capscrew (116).



- b. If removal was necessary, install new gasket (115) and suction screen (114).
- c. If removal was necessary, install expansion plug (116).
- d. If removal was necessary, install two locating bushings (113).
- e. If removal was necessary, install elbow (111), dipstick tube (110), dipstick (109), clamp (108) and capscrew (107) on transmission case (112).

### **NOTE**

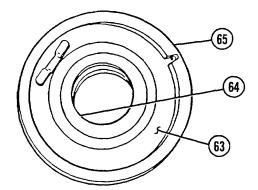
Wipe all sealing surfaces clean and dry. Apply film of hydraulic oil to all parts as they are installed.

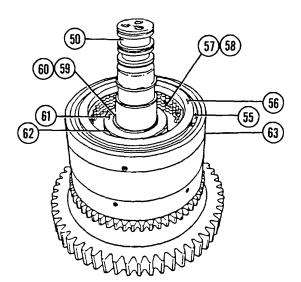
- 1. ASSEMBLE FIRST STAGE CLUTCH PACK (46).
  - a. Install new outer piston seal (65) onto piston (63).
  - b. Install new O-ring (64) onto shaft assembly (50).

### **CAUTION**

Use care when installing assembled piston (63) to prevent damage to O-ring (64) and outer piston seal (65).

- Install assembled piston (63) into shaft assembly (50). Ensure that piston (63) aligns with locating pins in shaft assembly (50).
- d. Install thrust washer (62), four springs (61) and retainer (59).





### **WARNING**

Springs (61) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

e. Place shaft assembly (50) in a press. Install a spring compressor tool.

### WARNING

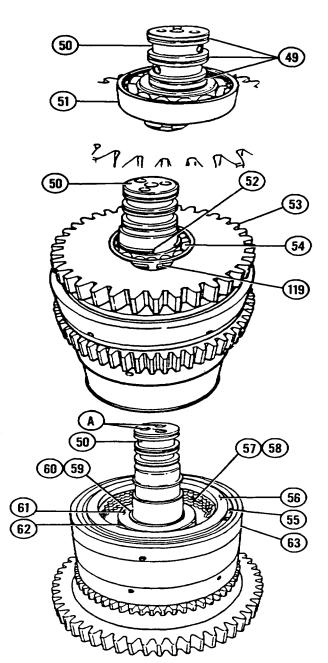
Ensure that retainer ring (60) is secure in groove before spring compressor tool is removed from retainer (59) to prevent springs (61) from flying out. Failure to follow this precaution could cause personal injury.

f. Press down on spring compressor tool and retainer (59) to allow installation of retainer ring (60). Slowly remove spring compressor tool.

# **CAUTION**

Carefully handle clutch plates (57) so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

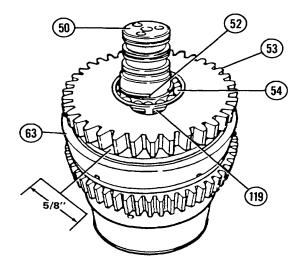
g. Install six separator plates (58) and six clutch plates (57) into shaft assembly (50). Begin with a separator plate (58) and then a clutch plate (57). Continue by alternating plates. The last plate must be a clutch plate (57).

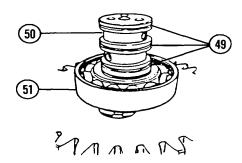


### **NOTE**

The separator plates (58) have external teeth and clutch plates (57) have internal teeth. The plates do not have a right or wrong side for installation.

- h. Install retainer (56) and snap ring (55) on shaft assembly (50).
- i. Install appropriate pair of alignment bars between weld gear (53) and piston (63), as required, to hold weld gear (53) off piston (63). Use either narrow or wide side of bars to ensure that weld gear (53) is held off piston (63) 5/8" and at the same time engages all clutch plates (57).
- j. Install weld gear (53) on shaft assembly (50). Turn weld gear (53) so it meshes with clutch plates (57) and separator plates (58). Push weld gear (53) until it bottoms out. Weld gear (53) splines must be in full position with internal teeth of all clutch plates (57).
- k. Using an assistant to spread snap ring (119), use a bearing driver to press bearing (54) onto shaft assembly (50) and into weld gear (53). Remove alignment bars to seat bearing (54) and weld gear (53) as an assembly.
- I. Install snap ring (52). Ensure that snap ring (52) is fully in groove of shaft assembly (50).
- m. Use a bearing driver to press bearing (51) onto shaft assembly (50).
- n. Apply grease to three seal rings (49) and install.





- o. Turn shaft assembly (50) over and repeat STEPS a-m.
- 2. ASSEMBLE SECOND STAGE CLUTCH PACK (47).
  - a. Install new outer piston seal (86) onto piston (84).
  - b. Install new O-ring (85) onto shaft assembly (67).

# **CAUTION**

Use care when installing piston (84) to prevent damage to O-ring (85) and outer piston seal (86).

- c. Install assembled piston (84) onto shaft assembly (67). Ensure that piston (84) aligns with locating pins in shaft assembly (67).
- d. Install thrust washer (83), four springs (82) and retainer (80).

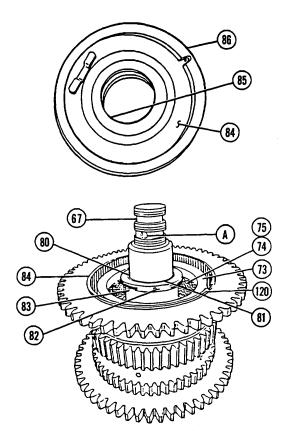
# **WARNING**

Springs (82) are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

e. Place shaft assembly (67) in a press. Install a spring compressor tool.

## WARNING

Ensure that retainer ring (81) is secure in groove before spring compressor tool is removed from retainer (80) to prevent springs (82) from flying out. Failure to follow this precaution could cause personal injury.



f. Press down on spring compressor tool and retainer (80) to allow installation of retainer ring (81). Slowly remove spring compressor tool.

#### **CAUTION**

Carefully handle clutch plates (74) so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

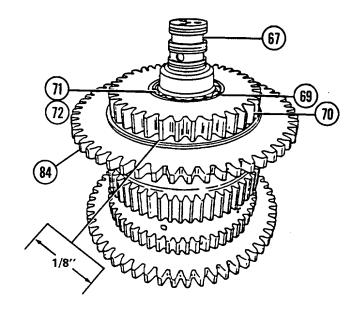
g. Install six clutch plates (74) and six separator plates (75) into shaft assembly (67). Begin with a separator plate (75) and then a clutch plate (74). Continue by alternating plates. The last plate must be a clutch plate (74).

#### NOTE

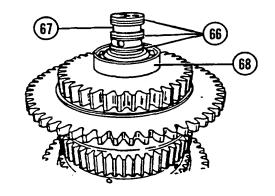
The separator plates (75) have external teeth and clutch plates (74) have internal teeth. The plates do not have a right or wrong side for installation.

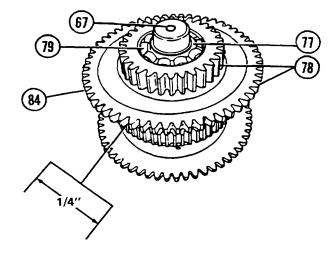
h. Install retainer (73) on shaft assembly (67).

- i. Install snap ring (120).
- j. Install appropriate pair of alignment bars between weld gear (70) and piston (84) as required to hold weld gear (70) off piston (84). Use either narrow or wide side of bars to ensure that weld gear (70) is held off piston (84) 1/8" and at the same time engages all clutch plates (74).
- k. If removed, install snap ring (72) in weld gear (70).
- I. Install weld gear (70) on shaft assembly (67).



- m. Use a bearing driver to press bearing (71) onto shaft assembly (67) and into weld gear (70). Remove alignment bars to seat bearing (71) and weld gear (70).
- n. Install snap ring (69). Ensure that snap ring (69) is fully in groove of shaft assembly (67).
- o. Use a bearing driver to press bearing (68) onto shaft assembly (67).
- p. Apply grease to three seal rings (66) and install.
- q. Turn shaft assembly (67) over and repeat STEPS a-h.
- r. Install weld gear (78) on shaft assembly (67). Turn weld gear (78) so it meshes with clutch plates (74) and separator plates (75). Push weld gear (78) until it bottoms out. Weld gear (78) splines must be in full position with internal teeth of all clutch plates (74).
- s. Remove weld gear (78).
- t. Press one bearing (79) onto shaft assembly (67) until it is tight against snap ring.
- u. Install appropriate pair of alignment bars between weld gear (78) and piston (84), as required, to hold weld gear (78) off piston. Use either narrow or wide side of bars to ensure that weld gear (78) is held off piston 1/4" and at the same time engages all clutch plates.
- v. Install weld gear (78) on shaft assembly (67).



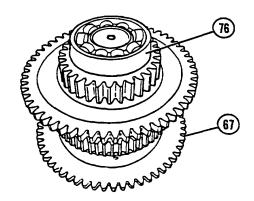


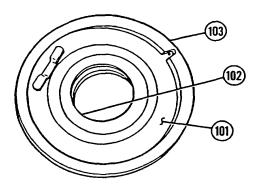
- w. Press one bearing (79) onto shaft assembly (67) and into weld gear (78). Remove alignment bars to seat bearing (79) and weld gear (78).
- x. Install snap ring (77) onto shaft assembly (67).
- y. Press bearing (76) onto shaft assembly (67).
- 3. ASSEMBLE THIRD STAGE CLUTCH PACK (48).
  - a. Install new outer piston seal (103) onto piston (101).
  - b. Install new O-ring (102) on shaft assembly (88).

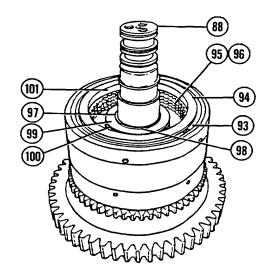
### **CAUTION**

Use care when installing piston (101) to prevent damage to O-ring (102) and outer piston seal (103).

- c. Install assembled piston (101) into shaft assembly (88). Ensure that piston (101) aligns with locating pins in shaft assembly (88).
- d. Install thrust washer (100), four springs (99) and retainer (97).
- e. Place shaft assembly (88) in a press. Install a spring compressor tool.







### **WARNING**

Ensure that retainer ring (98) is secure in groove before spring compressor tool is removed from retainer (97) to prevent springs (99) from flying out. Failure to follow this precaution could cause personal injury.

f. Press down on spring compressor tool and retainer (97) to allow installation of retainer ring (98). Slowly remove spring compressor tool.

### **CAUTION**

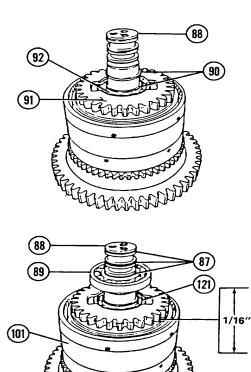
Carefully handle clutch plates (95) so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

g. Install four clutch plates (95) and four separator plates (96) into shaft assembly (88). Begin with a separator plate (96) and then a clutch plate (95). Continue by alternating plates. The last plate must be a clutch plate (95).

#### NOTE

The separator plates (96) have external teeth and clutch plates (95) have internal teeth. The plates do not have a right or wrong side for installation.

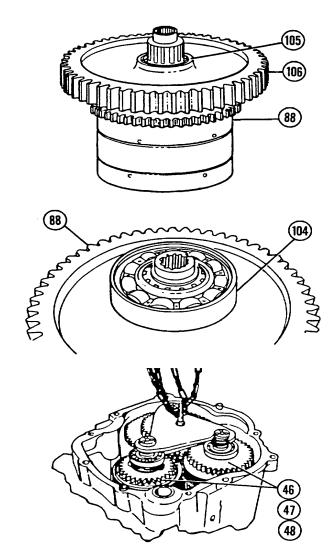
- h. Install clutch plate retainer (94) and snap ring (93) on shaft assembly (88).
- i. Install appropriate pair of alignment bars between weld gear (91) and piston (101), as required, to hold weld gear (91) off piston (101). Use either narrow or wide side of bars to ensure that weld gear (91) is held off piston (101) 1/16" and at the same time engages all clutch plates (95).



- j. Install weld gear (91) on shaft assembly (88).
- k. Using an assistant to spread snap ring (121) use a bearing driver to press bearing (92) onto shaft assembly (88) and into weld gear (91).
- I. Install two snap rings (90). Ensure that snap rings (90) are fully in grooves of shaft assembly (88).
- m. Use a bearing driver to press bearing (89) onto shaft assembly (88).
- Apply grease to three seal rings (87) and install.
- o. Turn shaft assembly (88) over and press gear (106) onto shaft assembly (88).
- p. Install snap ring (105) onto shaft assembly (88).
- q. Tap or press bearing (104) onto shaft assembly (88).

# 4. INSTALL THREE CLUTCH PACKS (46-48).

- a. Place first stage clutch pack (46) on a wood block. Move the assembled three clutch packs (46-48) together.
- b. Install a special lifting tool in bottom groove of all three clutch pack (46-48) shafts.
- c. Attach a hoist with slings to special lifting tool and install clutch packs (46-48) into main case.
- d. Ensure that clutch packs (46-48) are in proper position and sequence before removing special lifting tool. Ensure that bearings engage with seats in main case.



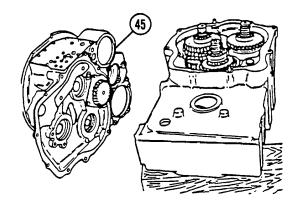
- 5. INSTALL FRONT COVER ASSEMBLY (45), PARA. **7-5.**
- 6. INSTALL TRANSMISSION CONTROL VALVE (44), PARA. 7-8.

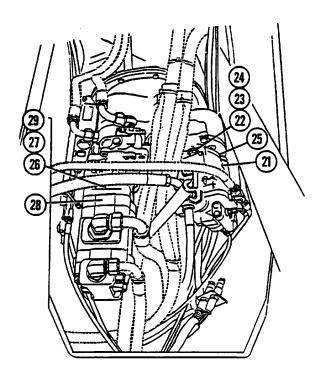
# **INSTALLATION**

### **NOTE**

After transmission repair or replacement, ensure that parts not issued with transmission are removed and installed on new transmission.

- 1. INSTALL TANDEM GEAR PUMP (28) ON TRANSMISSION.
  - Install new O-ring (29) on hydraulic gear pump drive.
  - b. Place tandem gear pump (28) in position on transmission oil pump.
  - c. Install two new lockwashers (27) and two hex head capscrews (26).
- 2. INSTALL PISTON PUMP (21) ON TRANSMISSION.
  - a. Install a new O-ring (25) on hydraulic piston pump drive adapter.
  - b. Place piston pump (21) in position on transmission.
  - c. Install two flatwashers (24), two new lockwashers (23) and two hex head capscrews (22).





#### 3. INSTALL TRANSMISSION IN VEHICLE.

Apply Loctite #242 to threads of four capscrews (36). Install left front transmission mounting bracket (38), four new lockwashers (37) and four capscrews (36). Torque capscrews (36) to 220 lb. ft.

# **NOTE**

Weight of transmission (43) is 846 lbs.

- b. Attach a hoist with slings to transmission (43). Place slings under input yoke and output yokes. Secure slings together.
- c. Lift transmission (43) into vehicle. Ensure that hoses and other obstructions are clear of transmission during installation. Lower transmission until its mounts are resting on transmission supports.
- 4. INSTALL PARTS (32-35 AND 40-42).

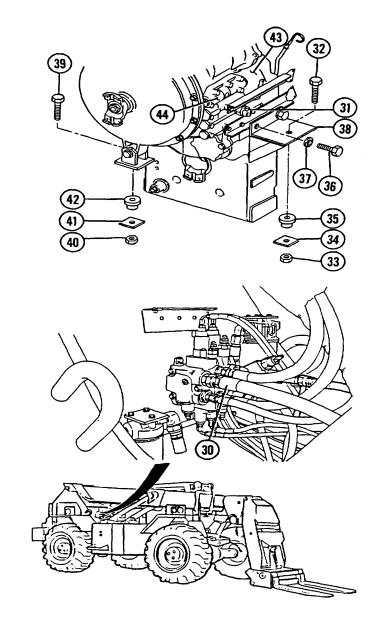
#### NOTE

Place a drift and wedge between capscrew (39) and side of rear transmission mount to prevent capscrew (39) from moving when tightening nut (40).

- a. Apply Loctite #242 to threads of capscrew (39). Install nut (40), rebound washer (41), rubber mount (42) and capscrew (39) in rear transmission mount. Torque nut (40) to 307 ft. lb.
- Apply Loctite #242 to threads of two hex head capscrews (32). Install two rubber mounts (35), two rebound washers (34), two nuts (33) and two hex head capscrews (32). Torque nuts (33)

to 307 ft. lb

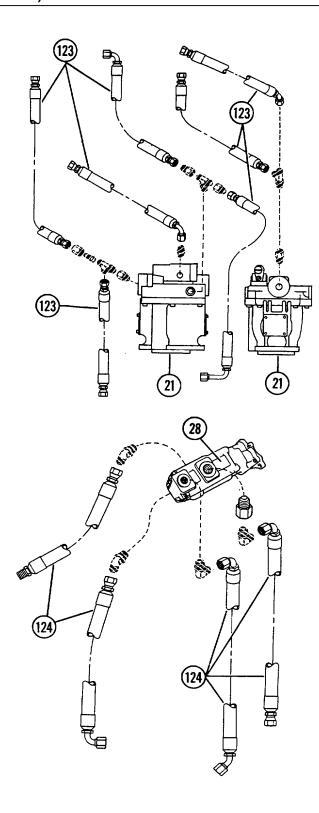
c. Remove slings from transmission (43).



- 5. CONNECT TWO LEADS TO NEUTRAL SAFETY SWITCH
- 6. CONNECT HOSE (30) AT MAIN CONTROL VALVE (BETWEEN MAIN CONTROL VALVE ASSEMBLY AND PRIORITY VALVE).

7. INSTALL SEVEN HYDRAULIC HOSES (123) TO PISTON PUMP (21).

8. INSTALL FOUR HYDRAULIC HOSES (124) TO TANDEM GEAR PUMP (28).



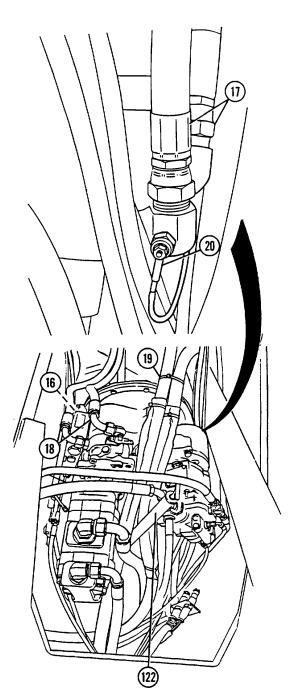
- 9. INSTALL TRANSMISSION OIL FILLER TUBE (122).
- 10. CONNECT LEAD (20) TO TRANSMISSION TEMPERATURE SENDER.
- 11. INSTALL A NEW TIE WRAP (19) TO UPPER HOSES THAT CONNECT HYDRAULIC CONTROL VALVE TO TRANSMISSION AND HYDRAULIC PUMPS.

# **NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on transmission and hoses clean and dry. Apply film of clean transmission oil as they are installed.

# 12. CONNECT HOSES (16-18).

- Connect two transmission oil filter hoses (18) on transmission.
- b. Connect two transmission oil cooler hoses (17) on transmission.
- c. Connect transmission disconnect valve hose (16) to transmission control valve.

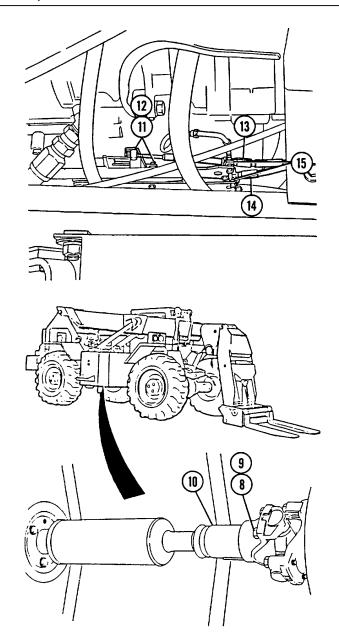


- 13. CONNECT TRANSMISSION CABLES (13 AND 14) TO TRANSMISSION CONTROL VALVE.
  - a. Connect transmission cables (13 and 14) to transmission control valve.

### NOTE

Ensure that cables (13 and 14) are connected correctly for proper function.

- b. Install four nuts (15) that secure clamps for transmission cables (13 and 14).
- c. Install washer (12) and new cotter pin (11) for each transmission cable (13 and 14) at transmission control valve.
- 14. APPLY LOCTITE #242 ON THREADS OF FOUR CAPSCREWS (8). SLIDE YOKE OF TRANSMISSION PROPELLER SHAFT (10) TOWARD TRANSMISSION INPUT YOKE AND SECURE WITH FOUR NEW LOCKWASHERS (9) AND FOUR CAPSCREWS (8).TORQUE CAPSCREWS TO 45 LB. FT.



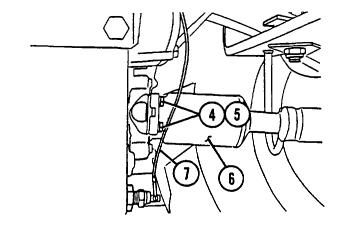
- 15. CONNECT LEAD (7) TO TRANSMISSION TEMPERATURE SWITCH.
- 16. CONNECT SHAFTS (3 AND 6) ON TRANSMISSION.
  - a. Apply Loctite #242 on threads of capscrews
     (4). Install rear propeller shaft (6) and secure with four new lockwashers (5) and four capscrews (4). Torque capscrews (4) to 45 lb. ft.
  - Apply Loctite #242 on threads of capscrews

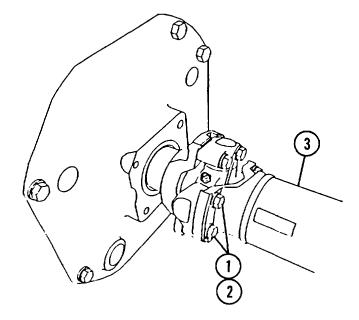
     (1). Install front propeller shaft (3) and secure with four new lockwashers (2) and four capscrews (1). Torque capscrews to 45 lb. ft.
- 17. ENSURE THAT TRANSMISSION DRAIN PLUG IS IN POSITION.
- 18. SERVICE TRANSMISSION, LO10-3930-660-12.

# **CAUTION**

Do not start engine until both piston and tandem gear pumps are primed. Failure to follow this instruction may result in damage to pumps.

- 19. PURGE AIR (PRIME) FROM PISTON AND TANDEM GEAR PUMPS, TM10-3930-660-20.
- 20. START ENGINE AND ALLOW TO RUN FOR SEVERAL MINUTES, TM10-3930-660-10.
- 21. SHUT ENGINE DOWN, CHECK FLUID LEVEL AND REFILL AS NECESSARY, TM10-3930-660-10 AND TM10-3930-660-12.
- 22. INSTALL TRANSMISSION COVER, TM10-3930-660-20.





# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Lifting Device (Capacity 2000 lb.)

### **Equipment Condition**

Transmission assembly removed, para. 7-4.
Transmission control valve removed, para. 7-8.
Torque converter removed, para. 7-3.
Transmission oil pump removed, para. 7-9.

### Materials/Parts

Gasket (7)
Grease (App. B, Item 10)
Lockwashers (24)
Loctite #242 (App. B, Item 39)
Loctite #59241 (App. B, Item 42)
O-ring (26,27)
Permatex Sealant (App. B, Item 44)

### **REMOVAL**

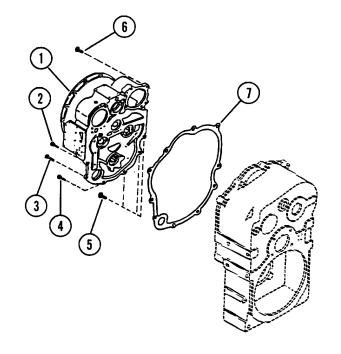
# **NOTE**

Transmission must be laying flat for front cover removal.

- ATTACH A HOIST OR OTHER SUITABLE LIFTING DEVICE TO MOUNTING BRACKETS ON FRONT COVER ASSEMBLY (1).
- REMOVE CAPSCREWS (2-4), THREE CAPSCREWS (5) AND FOUR CAPSCREWS (6).

# **CAUTION**

Use care when removing cover assembly (1). Clutch packs must remain in housing or clutch packs could be damaged during removal.



# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/REPAIR (Cont'd)

- 3. USE HOIST TO LIFT FRONT COVER ASSEMBLY (1) OFF MAIN CASE.
- 4. PLACE FRONT COVER ASSEMBLY (1) ON SUITABLE SUPPORTS.
- 5. REMOVE AND DISCARD GASKET (7).

#### **DISASSEMBLY**

- 1. REMOVE BEARING RETAINER (9) AND PARTS (8 AND 10-13).
  - a. Remove seven capscrews (8) and bearing retainer (9).
  - b. Remove oil seal (10).
  - c. Remove retaining ring (11) and bearing (12).
  - d. Remove Permatex gasket material between bearing retainer (9) and front cover (13).

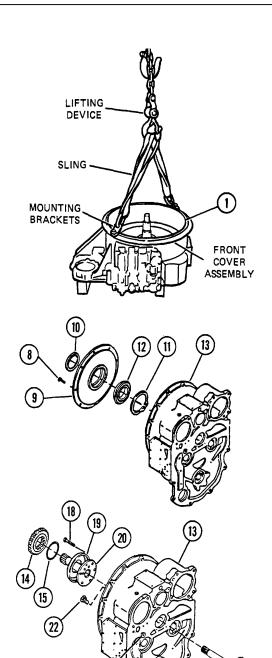
# 2. REMOVE PARTS (14-22).

- a. Remove hub impeller gear (14) and thrust washer (15).
- b. Remove three capscrews (16) and transmission input shaft (17) as an assembly.
- c. Remove six capscrews (18), cover plate (19) and stator support tube (20).

# **NOTE**

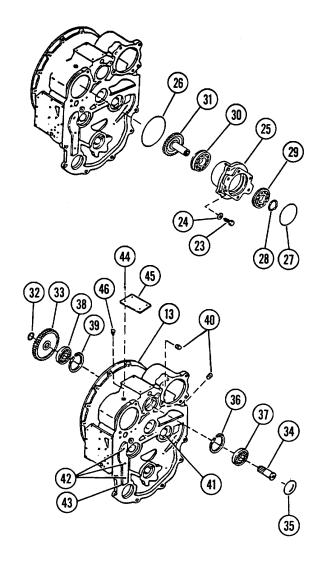
Do not remove high pressure line in front cover (13). The entire front cover assembly must be replaced if replacement of high pressure line is necessary. The high pressure line is not replaceable.

- d. Remove allen head pipe plug (21).
- e. Drive converter pressure relief valve (22) through pipe plug (21) opening in front cover (13).



# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/REPAIR (Cont'd)

- 3. REMOVE HYDRAULIC PISTON PUMP DRIVE ADAPTER (25).
  - Remove four capscrews (23), four lockwashers (24) and hydraulic piston pump drive adapter (25) as an assembly. Discard lockwashers (24).
  - b. Remove and discard O-rings (26 and 27).
  - c. Remove snap ring (28), bearing (29) and bearing roller (30) from auxiliary pump gear (31).
- 4. REMOVE AUXILIARY PUMP DRIVE ASSEMBLY PARTS (32-39).
  - a. Remove snap ring (32) and auxiliary pump gear (33).
  - b. Use a punch to strike shaft (34) until cover (35) comes off and shaft (34) comes out.
  - c. Remove snap ring (36) from front cover (13).
  - d. Remove bearing (37) from shaft (34).
  - e. Remove bearing (38) and snap ring (39) from front cover (13).
- 5. REMOVE PARTS (38-45) IF NECESSARY.
  - a. Remove two pipe plugs (40) if necessary.
  - b. Remove sleeve (41) if necessary.
  - c. Remove three capscrews (42) and oil passage cover (43) if necessary.
  - d. Remove four capscrews (44) and identification plate (45) if necessary.
  - e. Remove breather (46) if necessary.



# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/RPAIR (Cont'd)

### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### INSPECTION

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

- 1. IF REMOVAL WAS NECESSARY, INSTALL PARTS (40-46).
  - a. If removal was necessary, apply Loctite #59241 and install breather (46).
  - b. If removal was necessary, install identification plate (43) and four capscrews (44).
  - c. If removal was necessary, install oil passage cover (43) and three capscrews (42).
  - d. If removal was necessary, install sleeve (41). Align index mark on sleeve (41) to center of locating hole.
  - e. If removal was necessary, apply Loctite #59241 and install two pipe plugs (40).

### **NOTE**

When installing cover (35), apply Loctite #242.

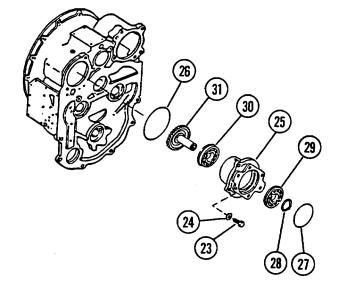
- INSTALL AUXILIARY PUMP DRIVE PARTS (32-39).
  - a. Install snap ring (39) and bearing (37) in front cover (13).
  - b. Install snap ring (36) inside front cover (13).
  - c. Install bearing (37) on shaft (34).

# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/REPAIR (Cont'd)

- d. Install shaft (34) with bearing (37) in front cover (13).
- e. Use a suitable puller to pull shaft (34) through front side of front cover (13) and through auxiliary pump gear (33) until snap ring groove is seen.
- f. Install snap ring (32).
- g. Apply Loctite #242 to cover (35) and press onto front cover (13).
- 3. INSTALL HYDRAULIC PISTON PUMP DRIVE ADAPTER (25).
  - a. Install bearing roller (30) and bearing (29) on shaft of auxiliary pump gear (31).
  - b. Install snap ring (28).
  - c. Slide parts (28-31) as an assembly into hydraulic piston pump drive adapter (25).
  - d. Install new O-rings (26 and 27) on hydraulic piston pump drive adapter (25).
  - e. Install hydraulic piston pump drive adapter (25), four new lockwashers (24) and four capscrews (23).

#### **NOTE**

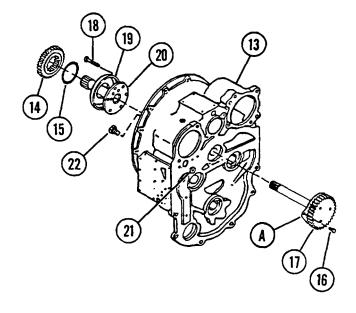
When installing capscrews (16), apply Loctite #242.

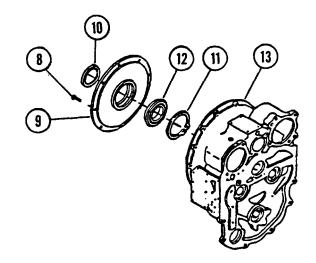


# 7-5. TRANSMISSION FRONT COVER ASSEMBLY - REPLACE/REPAIR (Cont'd)

# 4. INSTALL PARTS (14-22).

- Apply Loctite #242 to converter pressure relief valve (22) and drive into bore until valve seat shoulders against bottom of bore.
- b. Apply Loctite #59241 and install allen head pipe plug (21) to back side of front cover (13).
- c. Install stator support tube (20), cover plate (19) and six capscrews (18).
- Install transmission input shaft (17), as an assembly, through back of front cover (13). Ensure that flat side of bearing retainer (A) is against front cover (13).
- e. Apply Loctite #242 on threads of three capscrews (16) and install.
- f. Install thrust washer (15) against cover plate (19).
- g. Install impeller gear (14) against thrust washer (15).
- 5. INSTALL PARTS (8 AND 10-13) AND BEARING RETAINER (9).
  - a. Install bearing (12) with retaining ring (11) on bearing retainer (9).
  - b. Install oil seal (10) in bearing retainer (9).
  - c. Apply Permatex gasket material to bearing retainer (9). Ensure that oil seal (10) is on the outside before installing bearing retainer (9). Install bearing retainer (9) and seven capscrews (8).





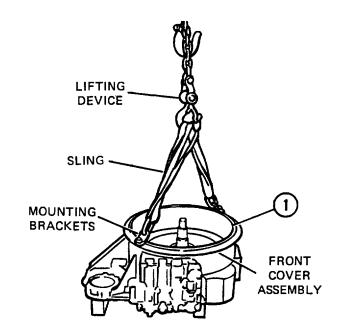
### 7-5. TRANSMISSION FPRIT COVER ASSEMBLY - REPLACE/REPAIR (Cont'd)

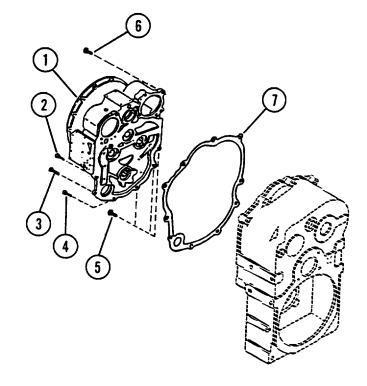
#### **INSTALLATION**

- 1. INSTALL FRONT COVER ASSEMBLY (1).
  - a. Ensure that two locator bushings are in position on main case. The locator bushings align front cover assembly (1).
  - b. Place new gasket (7) on main case.
  - c. Use a hoist to lift front cover assembly (1) and place it on main case.
  - d. It may be necessary to rotate input shaft (17) slightly to line up gear teeth in front cover clutch packs.
- 2. INSTALL FOUR CAPSCREWS (6), THREE APSCREWS (5) AND CAPSCREWS (2-4). TORQUE CAPSCREWS TO 50 LB. FT.
- 3. INSTALL TRANSMISSION OIL PUMP, PARA. 7-9.
- 4. INSTALL TORQUE CONVERTER, PARA. 7-3.
- 5. INSTALL TRANSMISSION CONTROL VALVE, PARA. 7-

8.

6. INSTALL TRANSMISSION ASSEMBLY, PARA. 7-4.





#### 7-6. TRANSMISSION OUTPUT SHAFT - REPLACE/REPAIR/ADTJUST

### This task covers:

a. Removal

c. Inspection

e. Pre-Load Check of Bearing

b. Disassembly

d. Reassembly

f. Installation

#### **INITIAL SETUP:**

### **Tools**

Tool Kit, Automotive Mechanics Shop Equipment, Automotive Maintenance, Common #2, Less Power

# Materials/Parts

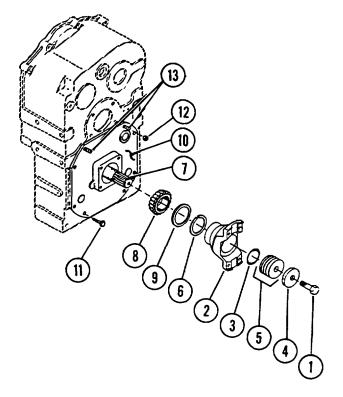
Hydraulic Oil (App. B, Item 35) O-ring (3, 19) Wood Blocks

# **Equipment Condition**

Front and rear propeller shafts removed, TM10-3930-660-20. Transmission oil drained, LO10-3930-660-12.

#### **REMOVAL**

- REMOVE CAPSCREW (1), YOKE (2), O-RING (3), WASHER (4) AND SHIMS (5). DISCARD O-RING (3).
- PLACE TRANSMISSION ON BLOCKS WITH CONVERTER SIDE VERTICAL.
- 3. REMOVE PARTS (6-21) AND OUTPUT SHAFT (7).
  - a. Remove snap ring (6). Push output shaft (7) toward converter side of main case.
  - b. Use a gear puller to remove bearing cone (8) and thrust race (9).
  - c. Mark position of output cap (10) with relation to main case. Remove two capscrews (11) and two nuts (12). Two studs (13) should stay in main case.



# 7-6. TRANSMISSION OUTPUT SHAFT - REPLACE/REPAIR/ADJUST (Cont'd)

# **CAUTION**

Use care when removing baffle pan (14). Failure to follow this precaution will damage machine parts.

- d. Remove the output cap (10). The baffle pan (14), gear (15) and bearing cone (16) will come off with output cap (10).
- e. Remove two cap screws (17) and oil baffle pan (14).
- f. Remove shims (18), O-ring (19), oil seal (20) and bearing cup (21) from output cap (10). Discard O-ring (19).
- g. Remove plug (22) if necessary.
- h. Remove plug (23) if necessary.
- Remove bearing cup (24) and oil seal (25) from main case.

### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

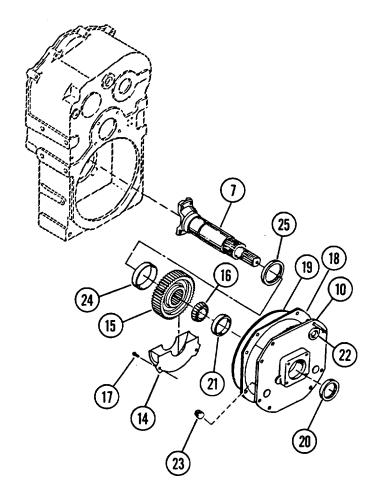
See Inspection Instructions, para. 2-11.

**INSTALLATION** 

### NOTE

Bearing cones must not be heated above 300° F. Freezing bearing cups is acceptable to aid for installation.

- 1. INSTALL PARTS (1-24).
  - a. Install oil seal (25) and bearing cup (24) in main case.
  - b. If removal was necessary, install plug (23).
  - c. If removal was necessary, install plug (22).



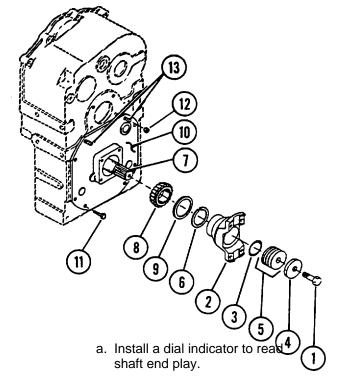
# 7-6. TRANSMISSION OUTPUT SHAFT - REPLACE/REPAIR/ADJUST (Cont'd)

- d. Install bearing cup (21) and oil seal (20) in output cap (10).
- e. Place case in vertical position. Install output shaft
   (7) with spacer screws to locate it in main case.
   Ensure that shaft (7) is installed straight and
   finished material of output shaft (7) yoke end is
   visible in front of seal.
- f. Install bearing cone (8), thrust race (9) and snap ring (6) onto shaft (7)
- g. Lay case down with output shaft (10) up. Install a new O-ring (19) in groove of output cap (10).
- h. Install bearing cone (16) in bearing cup (21).
- Place gear (15) in baffle pan (14). Install baffle pan (14) and two cap screws (17) to output cap (10).
- j. Install shims (18).
- k. Use two studs (13) as guide and carefully install output cap (10) with shims (18) on main case.
   Use care to prevent damage to oil seal (20) and O-ring (19)
- I. Install two nuts (12) and two cap screws (11). Ensure that output shaft (7) spins freely.
- m. Install yoke (2), new O-ring (3), shims (5), washer (4) and cap screw (1).

### **NOTE**

If a new yoke was installed, adjust shims (5) to obtain 0.005 inch gap between yoke (2) face and washer (4).

CHECK AND ADJUST OUTPUT SHAFT (7) END PLAY.



- b. Pull up on output shaft (7) and read end play on dial indicator.
- c. If end play is not within 0.000 to 0.004 inch, adjust shims (5) as necessary to bring end play within specifications.
- d. Remove indicator and base.
- 3. INSTALL FRONT AND REAR PROPELLER SHAFTS, TM10-3930-660-20.
- 4. FILL TRANSMISSION WITH OIL, L010-3930-660-12.

#### 7-7. TRANSMISSION INPUT SHAFT - REPLACE/REPAIR

### This task covers:

a. Removal

b. Disassembly

- c. Cleaning
- d. Assembly
- e. Installation

#### **INITIAL SETUP:**

### **Tools**

Tool Kit, Automotive Mechanics Shop Equipment, Automotive Maintenance, Common #2, Less Power

# **Materials/Parts**

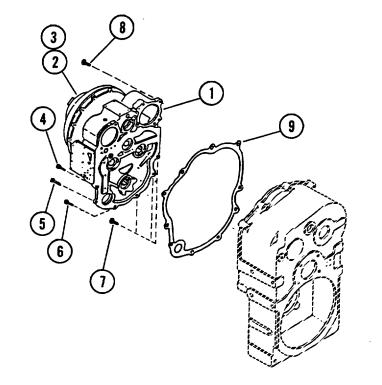
Gasket (9) Grease (App. B, Item 11) Loctite #242 (App. B, Item 41)

### **Equipment Condition**

Transmission assembly removed para. 7-4

# **REMOVAL**

- 1 REMOVE FRONT COVER ASSEMBLY (1), TORQUE CONVERTER (2) AND FRONT HOUSING (3) AS A UNIT FROM MAIN CASE.
  - a. Attach a hoist with sling, or other suitable lifting device, to front cover assembly (1), torque converter (2) and front housing (3) as a unit.
  - b. Remove cap screws (4-6), three cap screws (7) and four cap screws (8) which secure front cover assembly (1) to main case.
  - c. Use the hoist to lift unit off main case.
  - d. Remove and discard gasket (9).



### 7-7. TRANSMISSION INPUT SHAFT - REPLACE/REPAIR (Cont'd)

REMOVE THREE CAPSCREWS (10) AND TRANSMISSION INPUT SHAFT (11) AS AN ASSEMBLY.

#### DISASSEMBLY

- 1. REMOVE SEAL RING (12) FROM INPUT SHAFT (11).
- REMOVE SNAP RING (13) AND BALL BEARING (14).
- 3. REMOVE BEARING RETAINER (15).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **ASSEMBLY**

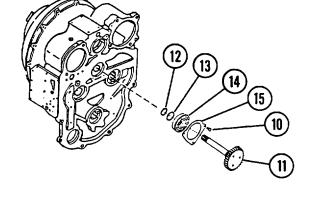
- 1. INSTALL BEARING RETAINER (15) ON INPUT SHAFT (11). ENSURE THAT FLAT SIDE OF BEARING RETAINER (15) FACES AWAY FROM INPUT SHAFT (11) GEAR.
- 2. INSTALL BALL BEARING (14) AND SNAP RING (13).
- 3. INSTALL SEAL RING (12).

# **INSTALLATION**

# **NOTE**

When installing cap screws (10), apply Loctite #242.

- 1. INSTALL INPUT SHAFT (9) AS AN ASSEMBLY.
  - a. Apply grease to seal ring (12) to center it on input shaft (11).
  - b. Install input shaft (11) as an assembly through bore in back of front cover assembly (1). Ensure that bearing retainer (15) is placed with flat side against front cover (1).
  - Apply Loctite #242 to threads of three cap screws (10) and install.



- INSTALL FRONT COVER ASSEMBLY (1), TORQUE CONVERTER (2) AND FRONT HOUSING (3) AS A UNIT TO MAIN CASE.
  - a. Place new gasket (9) on main case.
  - b. Attach a hoist with sling, or other suitable lifting device, to front cover assembly (1), torque converter (2) and front housing
  - c. Install four capscrews (8), three capscrews (7) and capscrews (4-6) which secure unit to main case. (3) as a unit. Lift unit into position on main case.
- 3. INSTALL TRANSMISSON ASSEMBLY, PARA. 7-4.

#### This task covers:

a. Removalb. Disassemblyc. Cleaningd. Inspectione. Assemblyf. Installation

#### **INITIAL SETUP:**

# **Tools**

Tool Kit, Auto-Mechanics Shop Equipment, Automotive Maintenance and Repair Maintenance, Basic, Less Power Tool Kit, Machinists: Post, Camp and Station

# **Materials/Parts**

Gasket (6) Hydraulic Oil (App. B, Item 35) Loctite #59241 (App B, Item 45) Oil Seal (22, 29) O-ring (9, 13, v17, 21, 25, 31, 37)

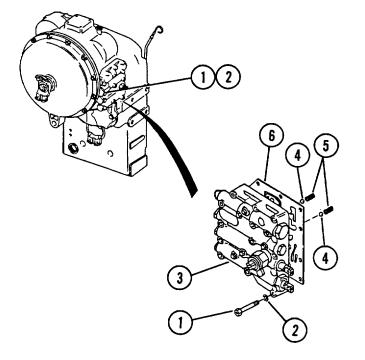
# **Equipment Condition**

Transmission Removed, para. 7-4

### **REMOVAL**

- REMOVE THIRTEEN SOCKET HEAD CAPSCREWS

   (1) AND THIRTEEN WASHERS (2) FROM TRANSMISSION VALVE (3).
- 2. REMOVE TRANSMISSION VALVE (3).
  - a. Pull transmission valve (3) straight out. Detent balls
    (4) are spring loaded and may fall out. Note position of balls (4) and springs (5).
  - b. Remove and discard gasket (6).
  - c. Remove two detent balls (4) and two springs (5) from back of transmission valve (3).



### **DISASSEMBLY**

1. REMOVE NEUTRAL START SWITCH (7).

# **CAUTION**

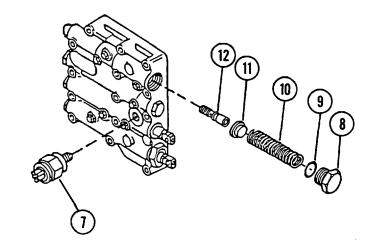
Do not over tighten vise jaws. Failure to follow this precaution will cause part damage.

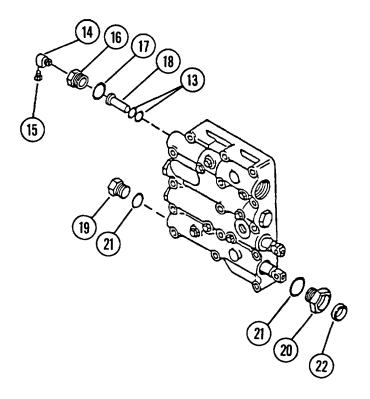
- 2. LINE VISE JAWS WITH SOFT MATERIAL TO AVOID DAMAGING VALVE HOUSING.
- 3. DISASSEMBLE TRANSMISSION VALVE (8-46).

# **WARNING**

The spring (10) is under compression. Use care when removing plug (8).

- a. Remove plug (8). Remove and discard O-ring (9).
- b. Remove return spring (10) and spring guide (11).
- c. Remove pressure valve assembly (12).
- d. Remove and discard two O-rings (13).
- e. Remove elbow (14). Remove plug(15) if necessary.
- Remove brake line plug (16). Remove and discard O-ring (17).
- g. Remove brake cutoff piston (18).
- h. Remove plugs (19 and 20). Remove and discard O-ring (21) from each plug (19 and 20).
- i. Remove and discard oil seal (22) from plug (20).





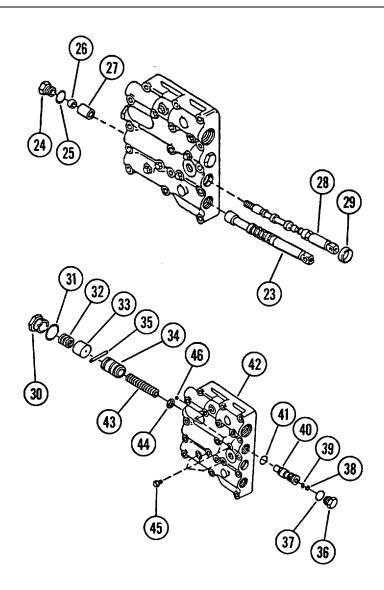
- Remove stem assembly (23) (range selector spool).
- k. Remove cap (24). Remove and discard O-Ring (25).
- L. Remove nut (26) and spacer (27).
- M. Remove stem (28) (directional spool). Remove and discard oil seal (29).
- N. Remove plug (30). Remove and discard Oring (31).
- O. Remove dump valve spring (32) and dump valve (33).
- P. Depress accumulator piston (34) and remove roller (35).
- Q. Remove plug (36). Remove and discard Oring (37).
- R. Remove snap ring (38), orifice plate (39), spool (40) and shims (41) from end of valve body (42).
- S. Remove accumulator piston (34), accumulator spring (43) and washer (44) from other end of valve body.
- T. Remove eight plugs (45) and one ball (46) if necessary.

### **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

See Inspection Instructions, para. 2-11.

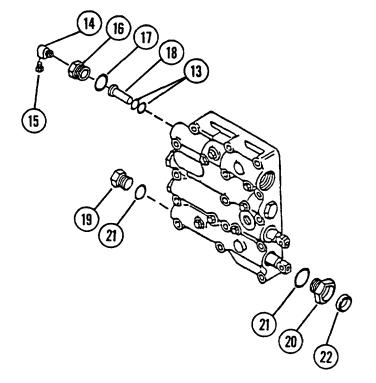


#### **ASSEMBLY**

### **NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all parts, except neutral start switch, as they are installed.

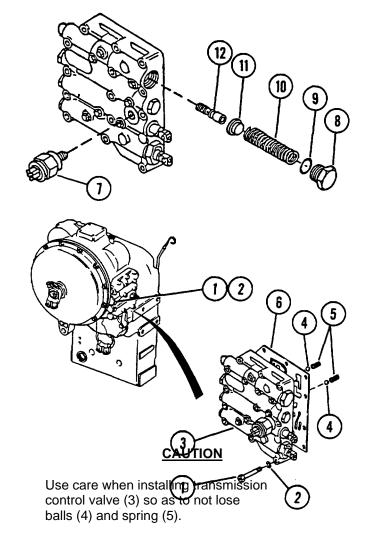
- ASSEMBLE TRANSMISSION CONTROL VALVE (1-46).
  - a. If removal was necessary, install one ball (46) and eight plugs (45). Ball (46) should be 0.03 inch below surface.
  - Install washer (44), accumulator spring (43) and accumulator piston (34) in one end of valve body (42). Depress accumulator piston (34) to compress spring (43) and install roller (35) in hole toward back of valve body (42).
  - c. Install dump valve (33) and dump valve spring (32).
  - d. Install new O-ring (31) on plug (30). Install plug (30).
  - e. Install shims (41), spool (40), orifice plate (39) and snap ring (38) on other side of valve body (42).
  - f. Install new O-ring (37) on plug (36). Install plug (36).
  - g. Install new oil seal (29) into valve body bore.
  - h. Install stem (28) (directional spool). Use care to prevent damage to oil seal (29).
  - i. Install spacer (27) and nut (26) on stem (28) (directional spool).



- j. Install new O-ring (25) on cap (24). Install cap (24).
- k. Install new O-ring (21) on plug (19 and 20). Install plug (19).
- I. Install stem assembly (23) (range selector spool).
- m. Install plug (20).
- n. Install new oil seal (22) in plug (20).
- o. Install two new O-rings (13) into top bore grooves.
- p. Install brake cutoff piston (18).
- q. Install new O-ring (17) on brake line plug (16). Install brake line plug (16).
- r. If removal was necessary, install plug (15) in elbow (14).
- s. Install elbow (14).
- t. Install pressure valve assembly (12), spring guide (11) and return spring (10).
- u. Install new O-ring (9) on plug (8). Install plug (8).
- 2. INSTALL NEUTRAL SAFETY SWITCH (7). APPLY LOCTITE #59241 TO THREADS OF NEUTRAL SAFETY SWITCH (7).

#### **INSTALLATION**

- 1. INSTALL TRANSMISSION VALVE (3).
  - a. Install two springs (5) and two detent balls (4) in back of transmission control valve (3).
  - b. Install new gasket (6).



- c. Install transmission control valve(3) over gasket (6).
- 2. INSTALL THIRTEEN WASHERS (2) AND THIRTEEN SOCKET HEAD CAPSCREWS (1).
- 3. INSTALL TRANSMISSION, PARA. 7-4.

### 7-9. TRANSMISSION OIL POMP - REPLACE/REPAIR

### This task covers:

a. Removalb. Disassembly

c. Cleaningd. inspection

e. Assembly f. Installation

### **INITIAL SETUP:**

# **Tools**

Tool Kit, Automotive Mechanics Shop Equipment, Automotive Maintenance, Common #2, Less Power Cap and Plug Set

# **Equipment Condition**

Tandem gear pump removed TM10-3930-660-20.

# Materials/Parts

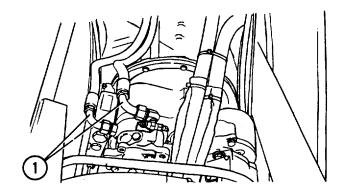
Alumilastic (App. B, Item 2) Gasket (6) Lock washers (5) Lock washers (10) O-ring (7, 11, 12)

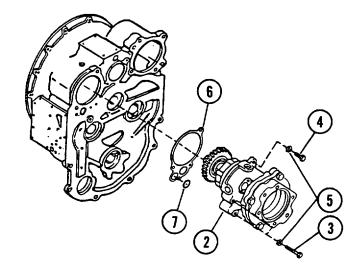
### **REMOVAL**

### **CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

- DISCONNECT TWO OIL LINES (1). CAP OR PLUG ALL OPENINGS.
- 2. SCRIBE TRANSMISSION OIL PUMP (2) AND FRONT COVER ASSEMBLY. THESE MARKS WILL ENSURE CORRECT ALIGNMENT DURING ASSEMBLY.
- 3. REMOVE THREE CAPSCREWS (3), ONE CAPSCREW (4), FOUR LOCKWASHERS (5) AND TRANSMISSION OIL PUMP (2). DISCARD LOCKWASHERS (5).
- 4. REMOVE AND DISCARD GASKET (6) AND O-RING (7).

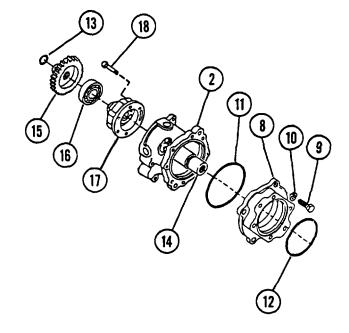


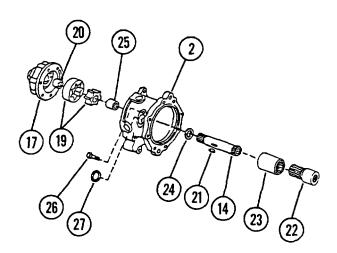


# 7-9. TRANSMISSION OIL PUMP - REPLACE/REPAIR (Cont'd)

# **DISASSEMBLY**

- 1. DISASSEMBLE RYDRAULIC GEAR PUMP DRIVE PARTS (8-12).
  - a. Scribe adapter (8) and transmission oil pump (2).
     These marks will be used for alignment during assembly.
  - b. Remove four capscrews (9), four lockwashers (10) and adapter (8). Discard lockwashers (10).
  - c. Remove and discard O-rings (11 and 12) from adapter (8).
- 2. DISASSEMBLE TRANSMISSION OIL PUMP PARTS (13-27).
  - a. Remove snap ring (13) from end of shaft (14).
  - b. Use a gear puller to pull gear (15) with bearing (16) from end of shaft (14).
  - c. Scribe retainer (17) and housing (2). These marks will be used during assembly.
  - d. Remove six capscrews (18) and retainer (17).
  - e. Remove two piece geroter (19).
  - f. Remove bearing (20) from retainer (17).
  - g. Remove wood ruff key (21) from key way in shaft (14).
  - h. Remove sleeve adapter (22) and sleeve spacer (23).
  - i. Remove shaft (14) and thrust race (24).
  - j. Remove bearing (25) from housing (2).





# 7-9. TRANSMISSION OIL PUMP - REPLACE/REPAIR (Cont'd)

k. Remove capscrew (26) and expansion plug (27) if necessary.

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

- 1. ASSEMBLE TRANSMISSION OIL PUMP PARTS (13-28).
  - a. If removal was necessary, install expansion plug (27) and capscrew (26).
  - b. Install bearing (25) 0.015 inch below surface in housing (2).
  - c. Install thrust race (24) and woodruff key (21) on shaft (14). Insert shaft (14) in housing (2).
  - d. Install bearing (20) in retainer (17).
  - e. Install two piece geroter (19) on shaft (14). The geroter must assemble freely over woodruff key (21) in shaft (14).
  - f. Install retainer (17) on housing (2). Ensure that scribe marks align.
  - g. Apply lute or alumilastic to threads of capscrews (18). Install six capscrews (18). Torque capscrews (18) to 17 ft. lbs.
  - h. Install sleeve spacer (23) and sleeve adapter (22) on shaft (14).
  - i. Install bearing (16) and gear (15) on end of shaft (14).

# 7-9. TRANSMISSION OIL PUMP - REPLACE/REPAIR (Cont'd)

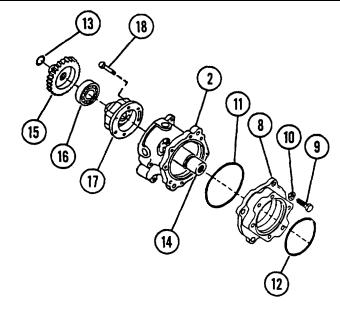
- j. Install snap ring (13).
- 2. ASSEMBLE HYDRAULIC GEAR PUMP DRIVE PARTS (8-12).
  - a. Install new O-rings (11 and 12) on adapter (8).
  - b. Install adapter (8) on transmission oil pump (2). Ensure that scribe marks align.
  - c. Install four new lockwashers (10) and four capscrews (9).

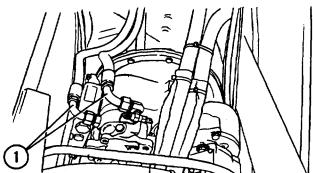
# **INSTALLATION**

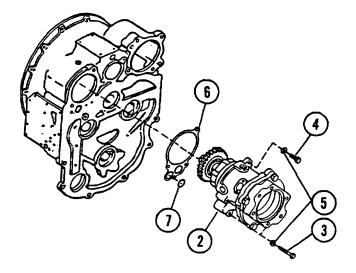
# **NOTE**

Remove caps and plugs from openings during installation. Wipe all sealing surfaces clean and dry.

- 1. INSTALL NEW O-RING (7) AND GASKET (6).
- 2. INSTALL TRANSMISSION OIL PUMP (2). ENSURE THAT SCRIBE MARKS ALIGN.
- INSTALL FOUR NEW LOCKWASHERS (5), ONE CAPSCREW (4) AND THREE CAPSCREWS (3).
- 4. CONNECT TWO OIL LINES (1) TO TRANSMISSION OIL PUMP.
  - 5. INSTALL DUAL GEAR PUMP, PARA. 16-3.







7-57/(7-58 Blank)

# **CHAPTER 8**

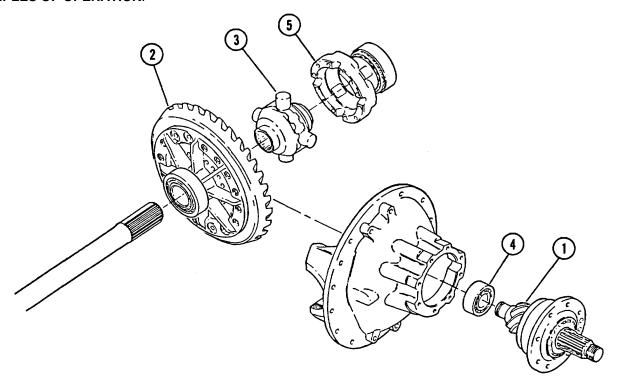
# FRONT AXLE MAITENANCE

# **Section I. DESCRIPTION AND DATA**

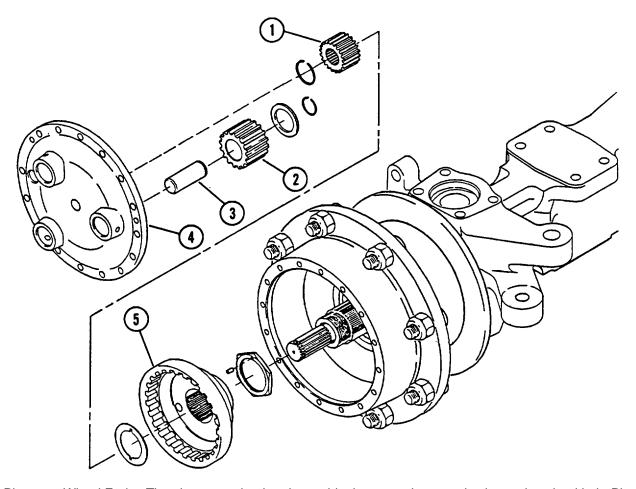
### 8-1. GENERAL.

Front axle maintenance procedures not covered in this section may be found in TM10-3930-660-20.

# 8-2. PRINCIPLES OF OPERATION.



a. <u>Differential</u>. The front differential provides the primary drive gear reduction. It is a single reduction carrier and is manufactured by Rockwell. This carrier has a hypoid drive pinion (1) and ring gear (2) set and a no-spin unit (3) in the differential assembly. A straight roller (spigot) bearing (4) is mounted on the head of the drive pinion (1). All other bearings in the carrier are tapered roller bearings. The no-spin differential unit (3) is contained in the differential case (5). When the carrier operates, the no-spin unit delivers one-hundred percent of the available power to both drive wheels, yet automatically allows normal differential action when required.



b. <u>Planetary Wheel Ends</u>. The planetary wheel ends provide the second gear reduction at the wheel hub. Planetary axles permit the bevel gearing of the carrier, and the axle shafts to carry nominal torsional load while providing the highest practical numerical gear reduction at the wheels.

The spur teeth of the planetary sun gear (1) mesh with teeth of the planetary gears (2). The planetary gears rotate on planetary pinion shafts (3) which are mounted on the planetary cover (4). The planetary gear (2) teeth, in turn, mesh with the teeth of the planetary ring gear (5).

Power is transmitted through the axle shafts to the sun gear, through the revolving planetary gears (1 and 2) and into the planetary cover (4) which drives the wheel hub.

# Section II. FRONT AXLE MAINTENANCE PROCEDURES

# FRONT AXLE MAINTENANCE TASK SUMMARY

TASK PARA	PROCEDURES	PAGE NO.
8-3	Front Axle Assembly Replace/Repair	8-3
8-4	Axle Pivot - Replace	8-9
8-5	Front Differential Carrier Assembly - Replace/Repair/Adjust	8-10
8-6	Front Planetary Wheel Ends - Replace	8-33

### 8-3. FRONT AXLE ASSEMBLY - REPLACE/REPAIR

### This task covers:

a. Removalb. Disassembly

c. Cleaningd. Inspection

e. Assembly f. Installation

# **INITIAL SETUP:**

### **Tools**

Tool Kit, Automotive Mechanics Shop Equipment, Automotive Maintenance, Common #2, Less Power Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power Cap and Plug Set

# **Equipment Condition**

vehicle parked on level service Parking brake set Rear wheels choked

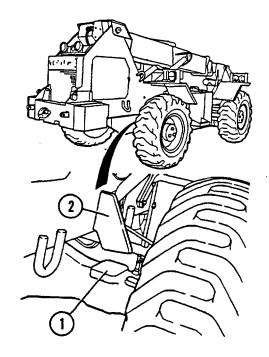
### Materials/Parts

Gear Oil Lubrication (App B, Item 32) Lint-Free rags (App B, Item 38) Locknut (8) Tags (App B, Item 52) Wood Blocks

# **Personnel Required**

Two Personnel

- PLACE WOOD BLOCKS (3 INCHES THICK)
   BETWEEN FRAME PADS (1) ON REAR AXLE
   AND FRAME TILT STOP PADS (2). THIS WILL PREVENT
   FRAME FROM TILTING WHEN REMOVING FRONT TILT
   CYLINDERS.
- 2. START ENGINE AND RAISE BOOM FOR SUFFICIENT WORK CLEARANCE.
- 3. DISCONNECT PARKING BRAKE CABLE, TM10-3930-660-20.
- 4. REMOVE FRONT PROPELLER SHAFT, TM10-3930-660-20.
- 5. RAISE FRONT OF VEHICLE 8 INCHES OFF GROUND AND SUPPORT UNDER FRAME, TM10-3930-660-20.



- 6. REMOVE FRAME TILT CYLINDER, TM10-3930-660-20.
- 7. REMOVE FRONT DISK BRAKE ASSEMBLIES, PARA. 10-3.
- 8. DISCONNECT AXLE BREATHER HOSE (3) FROM FRAME BY REMOVING NUT (4), LOCKWASHER (5), AND CLAMP (6). Discard lockwasher (5).

### **CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

#### **NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.

9. DISCONNECT FRONT STEERING CYLINDER HYDRAULIC SUPPLY HOSES (7).

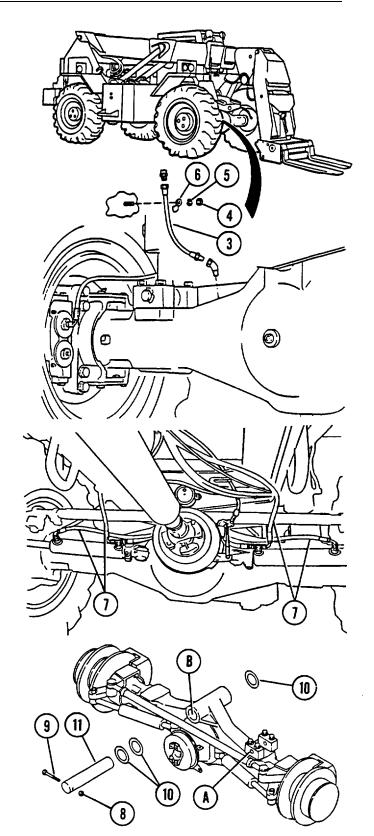
### NOTE

- Weight-of axle assembly is 1,650 lbs. (748kg).
- 10. USE A FLOOR JACK TO SUPPORT WEIGHT OF FRONT AXLE ASSEMBLY.
- 11. REMOVE AXLE PIVOT PIN (11).
  - a. Remove locknut (8) and retaining capscrew (9). Discard locknut (8).

# **NOTE**

Note the location and quantity of washer spacers (10) during disassembly. Keep washer spacers (10) together as a set.

b. Remove axle pivot pin (11) and washer spacers (10).

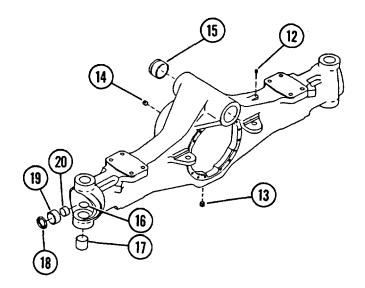


# 12. REMOVE AXLE ASSEMBLY.

- a. Place a steel bar (minimum 1 inch diameter and 6 feet long) in the tilt cylinder rod pivot pin mounting hole (A). The bar will prevent the axle assembly from rotating when the axle is removed.
- b. Lower floor jack and roll axle assembly to the front from under vehicle, using floor jack and 6 foot bar, to prevent axle assemble from rotating.
- c. Raise axle assembly using floor jack. Support axle assembly and wheels using suitable stands.

### **DISASSEMBLY**

- 1. REMOVE STEERING CYLINDERS, TM10-3930-660-20.
- 2. REMOVE TIE RODS, TM10-3930-660-20.
- 3. REMOVE PARKING BRAKE ASSEMBLY, TM10-3930-660-20.
- 4. REMOVE FRONT PLANETARY WHEEL ENDS, PARA. 8-6.
- 5. REMOVE FRONT DIFFERENTIAL CARRIER ASSEMBLY AND FRONT UNIVERSAL (CARDAN) STEERING JOINTS, PARA. 8-5.
- 6. REMOVE FRONT STEERING KNUCKLES, PARA. 12-3.
- 7. IF NECESSARY, REMOVE FOLLOWING PARTS.
  - a. Breather (12).
  - b. Drain plug (13).
  - c. Oil filler plug (14)
  - d. Two bushings (15).



- e. Four king pin plugs (16).
- f. Four king pin bushings (17).
- g. Two oil seals (18).
- h. Two sleeve assemblies (19).
- i. Two bushings (20).

### **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

See Inspection Instruction, para. 2-11.

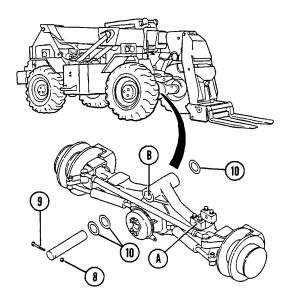
#### **ASSBMBLY**

- 1. IF REMOVED, INSTALL FOLLOWING PARTS:
  - a. Two bushings (20).
  - b. Two sleeve assemblies (19).
  - c. Two oil seals (18).
  - d. Four king pin backings (17).
  - e. Four king pin plugs (16).
  - f. Two bearings (15).
  - g. Oil filler plug (14).
  - h. Oil drain plug (13).
  - i. Breather (12).
- 2. INSTALL FRONT STEERING KNUCKLES, PARA. 12-3.
- 3. INSTALL FRONT DIFFERENTIAL CARRIER ASSEMBLY AND FRONT UNIVERSAL (CARDAN) STEERING JOINTS, PARA. 8-5.
- 4. INSTALL FRONT PLANETARY WHEEL ENDS, PARA. 8-6.

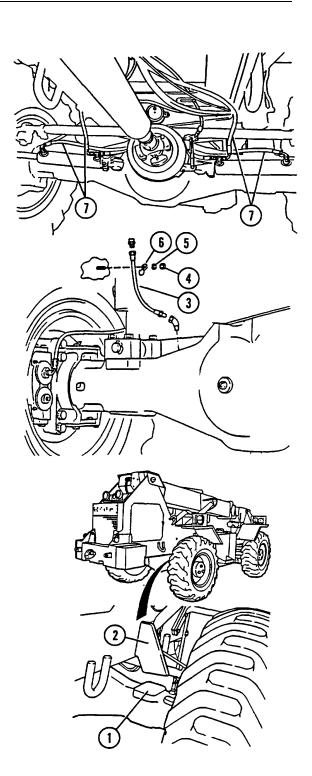
- 5. INSTALL PARKING BRAKE ASSEMBLY, TM10-3930-660-20.
- 6. INSTALL TIE RODS, TM10-3930-660-20.
- 7. INSTALL STEERING CYLINDERS, TM10-3930-660-20.

# **INSTALLATION**

- 1. PLACE A STEEL BAR (1 INCH MINIMUM DIAMETER AND 6 FEET LONG) IN THE TILT CYLINDER ROD PIVOT PIN MOUNTING HOLE (A). THE BAR WILL PREVENT THE AXLE ASSEMBLY FROM ROTATING WHEN INSTALLED.
- USE A FLOOR JACK TO RAISE AXLE ASSEMBLY.
- REMOVE STANDS.
- 4. LOWER AXLE ASSEMBLY UNTIL IT IS SUPPORTED BY TIRES.
- 5. ROLL AXLE ASSEMBLY UNDER VEHICLE, USING 6 FOOT BAR AND FLOOR JACK TO PREVENT THE AXLE ASSEMBLY FROM ROTATING.
- 6. ALIGN AXLE PIVOT PIN HOLE (B) WITH FRAME PIVOT PIN HOLES.
- 7. ENSURE WASHER SPACERS (10) ARE IN PLACE ON FRAME PIVOT PIN HOLE; USE FLOOR JACK TO CAREFULLY RAISE AXLE ASSEMBLY WHILE ASSISTANT HOLDS ASSEMBLY STEADY USING 6 FOOT BAR IN AXLE TILT CYLINDER MOUNTING HOLE ( A).
- 8. RAISE FLOOR JACK UNTIL AXLE PIVOT PIN HOLE (B) IS ALIGNED WITH FRAME PIVOT PIN HOLES.
- 9. SECURE FRONT AXLE TO FRAME WITH AXLE PIVOT PIN (11) AND WASHER SPACERS (10). AT LEAST ONE WASHER SPACER ON EACH SIDE OF AXLE PIVOT PIN HOLE IS REQUIRED.



- 10. SECURE AXLE PIVOT PIN WITH RETAINING CAPSCREW (9) AND NEW LOCKNUT (8) TORQUE CAPSCREW (9) TO 100 LB FT
- 11. USE A FLOOR JACK TO RAISE FRONT OF VEHICLE UNTIL VEHICLE FRAME CLEARS JACKSTANDS; REMOVE JACKSTANDS AND CAREFULLY LOWER VEHICLE
- 12. CONNECT FRONT STEERING CYLINDER HYDRAULIC SUPPLY HOSES (7)
- 13. CONNECT AXLE BREATHER HOSE (3) IN FRAME WITH CLAMP (6), NEW LOCKWASHER (5), AND NUT (4)
- 14. INSTALL FRONT DISC BRAKE ASSEMBLIES, PARA 10-3
- 15. INSTALL FRAME TILT CYLINDER, TM10-3930-660-20
- 16. INSTALL FRONT PROPELLER SHAFT, TM10-3930-660-20
- 17. INSTALL PARKING BRAKE CABLE, TM10-3930-660-20
- 18. REMOVE WOOD BLOCKS FROM BETWEEN FRAME PADS (1) ON REAR AXLE AND FRAME TILT STOP PADS (2)
- 19. BLEED HYDRAULIC STEERING
  CYLINDERS, BY ROTATING STEERING
  WHEEL 5 TIMES



### 8-4. AXLE PIVOT - REPLACE

This task covers:

- a. Removal
- b. Installation

# **Initial Setup**

**Tools** 

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

**Equipment Condition** 

Frame tilt cylinder removed, TM10-3930-660-20.

Materials/Parts Locknut (2)

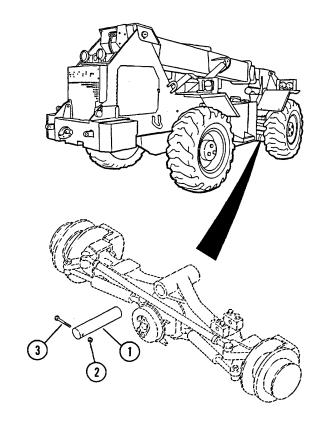
Personnel Required
Two Personnel

#### **REMOVAL**

- RAISE VEHICLE BY THE FRAME SO THAT WEIGHT OF VEHICLE IS OFF PIVOT PIN (1). DO NOT RAISE VEHICLE OFF GROUND.
- 2. SUPPORT VEHICLE UNDER FRAME USING SUITABLE STANDS.
- 3. REMOVE LOCKNUT (2) AND RETAINING CAPSCREW (3). DISCARD LOCKNUT (2).
- 4. REMOVE AXLE PIVOT PIN (1).

# **INSTALLATION**

- 1. INSTALL AXLE PIVOT PIN (1).
- 2. INSTALL RETAINING CAPSCREW (3) AND NEW LOCKNUT (2).
- 3. TORQUE RETAINING CAPSCREW (3) TO 100 LB. FT.
- 4. RAISE VEHICLE AND REMOVE STANDS.
- 5. LOWER VEHICLE.
- 6. INSTALL FRAME TILT CYLINDER, TM10-3930-660-20.



#### 8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY - REPLACE/REPAIR/ADJUST

#### This task covers:

- a. Removal
- b Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Adjustment
- g. Installation

# **Initial Setup**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Fabricated Tool - Differential Resistance Tool (App. C, Fig. C-3)

Fabricated Tool - Yoke Nut Tool (App. C, Fig. C-5)

Lifting Device, Capacity 2 Ton

# **Equipment Condition**

Front axle assembly removed, para. 8-3. Wheel assemblies removed, TM10-3930-660-20. Axle housing lubricant drained, TM10-3930-660-20. Both disc brake assemblies removed, para. 10-3. Front planetary wheel ends removed, para. 8-6.

### Materials/Parts

Cotter Pins (14) Gasket (33) Gear Lubricant (App. B, Item 32) Loctite #277 (App. B, Item 44) Oil Pan Prussian Blue Marking Compound (App. B, Item 6) Retaining Hardware - No Spin Differential Bolt, 1/4-20 x 7 in. Washers, 1-3/4 O.D. (Two) Wing Nut, 1/4-20 Rivets (27) RTV-732 Clear Sealing Compound (App. B, Item 7) Wood Blocks

# Personnel Required

Two Personnel

#### **REMOVAL**

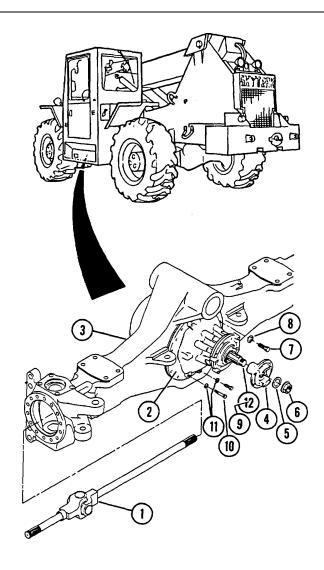
- 1. REMOVE AXLE SHAFTS (1).
- 2. REMOVE DIFFERENTIAL CARRIER (2) FROM AXLE HOUSING (3).

- a. Carefully tip axle assembly so that front differential carrier (2) faces up.
- Re-install companion flange (4), washer (5) and nut (6) that were removed with park brake assembly. The drive yoke will provide a lifting point for differential carrier (2) during removal.

## **NOTE**

Capscrews from differential carrier (2) to axle housing (3) are of three different sizes. Note size, location and quantity of capscrews when removing for correct location during replacement.

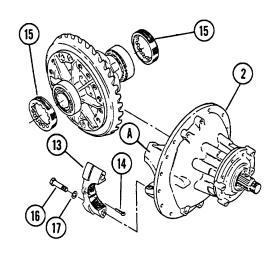
- c. Remove twelve capscrews (7), twelve flatwashers (8), two capscrews (9), two capscrews (10) and four flatwashers (11) from differential carrier (2).
- d. Use a leather or rubber mallet to loosen differential carrier (2) in axle housing.
- e. Use a sling placed around bevel pinion, behind companion flange (4), to lift and support the differential carrier (2) during removal.
- f. Carefully remove differential carrier (2) from axle housing (3).
- g. Place differential carrier (2) on stand or bench, with ring gear up, and clamp securely.
- h. Remove companion flange (4), nut(6) and washer (5) from bevel pinion (12).

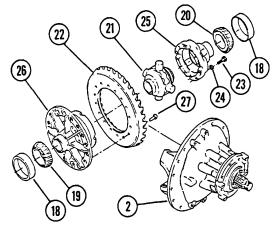


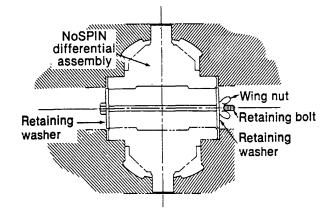
#### **DISASSEMBLY**

- REMOVE DIFFERENTIAL AND RING GEAR ASSEMBLY FROM CARRIER (2).
  - Use a center punch and hammer to mark one carrier leg (A) and bearing cap (13) to enable correct matching at reassembly.
  - Remove cotter pins (14) holding two bearing adjusting rings (15) in position. Discard cotter pins (14).
  - c. Remove two capscrews (16) and two flatwashers (17) from each of two bearing caps (13).
  - d. Remove two bearing caps (13) and two bearing adjusting rings (15).
  - e. Use a sling to lift the main differential and ring gear assembly from the carrier. Place the assembly on a work bench.
  - f. Remove two bearing cups (18).
  - g. Remove flange case half bearing cone (19) and plain case half bearing cone (20) with a suitable puller.
- DISASSEMBLE NO-SPIN DIFFERENTIAL (21) AND RING GEAR (22) ASSEMBLY.
  - If matching marks on the case halves of the differential are not visible, mark each case half with a center punch and hammer. The match marks are to ensure proper part orientation at assembly.
  - b. Secure the no-spin differential

     (21) with a bolt, a wing nut, and two flatwashers. See Materials/Pa!ts heading for retaining hardware dimensions.







## **WARNING**

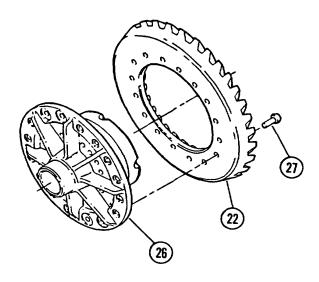
Failure to use a retaining bolt or other means of restraint can cause injury when removing the no-spin differential (21). The no-spin differential (21) contains compression springs under pressure.

- c. Remove eight capscrews (23) and eight flatwashers (24) from plain case half (25).
- d. Separate case halves (25 and 26) and remove no-spin differential (21).

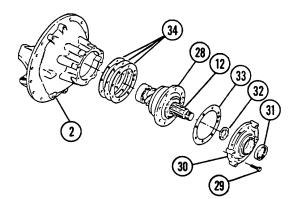
#### NOTE

The no-spin differential (21) is not serviceable and must not be disassembled. Do not remove the retaining bolt for inspection.

- e. Inspect the no-spin differential (21) for visible damage. Replace if damaged.
- 3. IF NECESSARY, REMOVE RING GEAR (22).
  - Inspect ring gear (22) for wear or damage. If ring gear (22) needs replacement, center punch twelve rivets (27) on side of ring gear (22).
  - b. Drill twelve rivets (27) on side of ring gear (22) to a depth equal to thickness of one rivet head. Use a drill bit 1/32 of an inch smaller than body diameter of rivet.
  - Press or drive twelve rivets (27) from drilled side through holes in ring gear (22) and flange case half (26). Discard rivets (27).



- d. Support assembly under ring gear (22) with metal or wood blocks and use a press to remove case half (26) through gear (22).
   Separate flange case half (26) and ring gear (22).
- 4. REMOVE BEVEL PINION (12) AND BEARING CAGE (28) FROM DIFFERENTIAL CARRIER (2).
  - a. Place differential carrier (2)
     on bench with bevel pinion (12)
     facing up. Clamp carrier
     securely.
  - b. Remove eight capscrews (29) and pinion bearing cage cover (30).
  - Use a suitable puller to remove bevel pinion bearing oil seal (31).
  - d. Remove pinion bearing cage thrust washer (32).
  - e. Remove pinion bearing cage cover gasket (33). Discard gasket (33).
  - f. Remove bevel pinion (12) with bearing cage (28) and shims (34) from the differential carrier (2). Keep shims together for use during assembly. If shims are damaged, measure total thickness of shim pack and note dimension; discard shims (34). Shim thickness dimension will be needed to calculate depth of bevel pinion in differential carrier when gear set is installed.



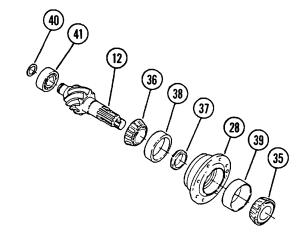
- 5. DISASSEMBLE BEVEL PINION (12) AND BEARING CAGE (28).
  - a. Place bevel pinion (12) and bearing cage (28) in a press with splined end at the top of assembly.
  - Support bearing cage (28) under flange area with metal or wood blocks.
  - Use a press or leather mallet and suitable driver to remove bevel pinion (12) from bearing cage (28).
  - d. Remove outer bearing (35) from bearing cage (28).
  - e. Use a suitable puller to remove inner bearing cone (36) and bearing spacer (37) from bevel pinion (12).
  - f. Use a suitable puller to remove inner bearing cup (38) and outer bearing cup (39) from bearing cage (28).
  - g. Install a soft metal cover over vise jaws to protect bevel pinion (12). Place bevel pinion (12) in a vise.
  - h. Use expanding snap ring pliers to remove snap ring (40) from end of bevel pinion (12).
  - i. Use a suitable puller to remove bearing (41) from spigot end of bevel pinion (12).

## **CLEANING**

See Cleaning Instructions, para. 2-10.

#### INSPECTION

See Inspection Instructions, para. 2-11.



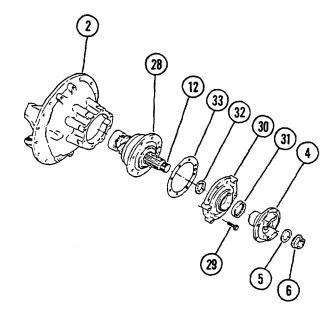
#### **ASSEMBLY**

#### **NOTE**

Pinion and ring gears are a matched set. If replacement of ring gear or pinion gear is necessary, replace both gears as a set.

- 1. ASSEMBLE BEVEL PINION (12), BEARINGS (35, 36, 37 AND 38) AND BEARING CAGE (28).
  - a. Use a press or suitable sleeve and driver to install inner bearing cup (38) and outer bearing cup (39) into bearing cage (28). Be sure bearing cups are flat against bottom of cage bore.
  - b. Use a press or suitable sleeve and driver to install inner bearing cone (36) on bevel pinion (12).
  - Use a press or suitable sleeve and driver to install spigot bearing (41) onto spigot end of bevel pinion (12).
  - d. Use an expanding snap ring pliers to install snap ring (40) into groove in end of bevel pinion (12).
  - e. Apply a thin film of gear lubricant to inner and outer bearing cups (38 and 39) and bearing cones (36 and 35).
  - f. Install bevel pinion (12) into bearing cage.
  - g. Install bearing spacer (37) on bevel pinion (12) against inner bearing cone (36).

- h. Use a press or suitable sleeve and driver to install outer bearing cone (35) on bevel pinion against bearing spacer (37).
- 2. INSTALL BEVEL PINION BEARING OIL SEAL (31).
  - a. Apply a thin film of gear lubricant to inner surface of bevel pinion bearing oil seal (31).
  - b. Apply a thin film of gear lubricant to seal bore in pinion bearing cage cover (30).
  - Use a press or suitable sleeve and mallet to install bevel pinion bearing oil seal (31) into pinion bearing cage cover (30).
  - d. Use a feeler gauge to check gap between pinion bearing oil seal (31) flange and pinion bearing cage cover (30) at several points around the seal (31). Gap must be within 0.015 to 0.030 inch. The difference between the largest and smallest gap measurements must not exceed 0.010 inch.
- 3. ADJUST PRELOAD OF BEARINGS (35, 36, 38 AND 39) ON BEVEL PINION (12).
  - a. Temporarily install bevel pinion (12) and bearing cage (28) assembly in differential carrier (2). Do not install shims (34) under bearing cage (28).
  - b. Install new gasket (33) on bearing cage (28).



- c. Install pinion bearing cage thrust washer (32), bearing cage (28) and bearing cage cover (30), and secure with eight capscrews (29). Hand tighten capscrews (29).
- d. Install companion flange (4), nut (6) and washer (5) on bevel pinion (12). Companion flange (4) must be against outer bearing.
- e. Fasten fabricated yoke nut tool (App. C, Fig. C-5) to companion flange (4). Use fabricated yoke nut tool to hold bevel pinion (12) in position when nut (6) is tightened.
- f. Torque nut (6) on bevel pinion (12) to 300 400 lb. ft.
- g. Remove fabricated yoke nut tool from companion flange (4).
- h. Attach a torque wrench on bevel pinion nut (6). Rotate bevel pinion (12) and read value indicated on torque wrench. New pinion bearings should be preloaded between 5 and 45 lb. in. of torque. Reused pinion bearings should be preloaded between 10 and 30 lb. in.

## **NOTE**

Do not read starting torque. Read only torque value after bevel pinion (12) starts to rotate. Starting torque will give a false reading.

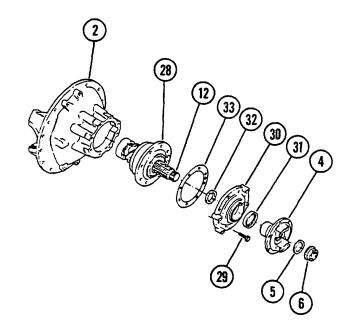
 Increase bearing preload by removing bevel pinion (12) and bearing cage (28) assembly from differential carrier (2) and installing a thinner bearing spacer (37). Repeat STEPS a through h.

- j. Decrease bearing preload by removing bevel pinion (12) and bearing cage (28) assembly from differential carrier (2) and installing a thicker bearing spacer (37). Repeat STEPS a through h.
- k. Remove nut (6), washer (5) and companion flange (4) from bevel pinion (12).
- I. Remove eight capscrews (29) and bearing cage cover (30).
- m. Remove bevel pinion (12) and bearing cage (28), as an assembly, from differential carrier (2).
- 4. IF REPLACEMENT OF BEVEL PINION (12)
  AND RING GEAR (22) SET IS NECESSARY,
  ADJUST THICKNESS OF SHIM PACK FOR
  NEW BEVEL PINION (12) AND RING GEAR
  (22) SET.

#### **NOTE**

If a new bevel pinion (12) and ring gear (22) set is installed, or if the depth of the bevel pinion (12) has to be adjusted, calculate the needed thickness of the shim pack using the following procedure:

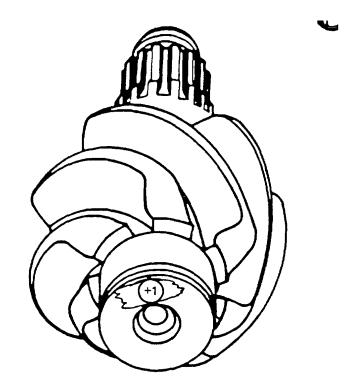
- Use a micrometer to measure thickness of old shim pack (34) removed from under bearing cage (28). Record measurement.
- Read variation number on spigot end of old bevel pinion (12).
   Record number.



#### **NOTE**

Bevel pinion spigot end number can be in 1, 000ths of an inch or 100ths of a millimeter. Example: +3 - .003 inch, +.03 - .03mm. Be sure to convert millimeters to inches by multiplying by 0.039 before performing the following calculations:

- c. Subtract number from spigot bearing end of old bevel pinion (12) from shim pack (34) thickness measured in STEP a. if old number is a plus (+) value. If old bevel pinion spigot number is a minus (-) value, add number from spigot end of old bevel pinion (12) to shim pack (34) thickness. This is the thickness of the standard shim pack, without a variation.
- d. Read number on spigot end of new bevel pinion (12). Record number.
- e. Add number from spigot end of new bevel pinion (12) to standard shim pack (34) thickness calculated in STEP c., if number on spigot end of new bevel pinion (12) is a plus (+). If new pinion cone number is a minus (-), subtract new pinion cone number from standard shim pack (34) thickness calculated in STEP c. This is the thickness of the new shim pack.



EXAMPLES:	
1.	
Old Shim Pack Thickness Old Bevel Pinio Spigot End Number, PC+2	0.030
Standard Shim Pack Thickness	0.028
New Bevel Pinion Spigot End Number, PC+5	+ 0.005
New Shim Pack Thickness	0.033
2.	
Old Shim Pack Thickness 0.030 Old Bevel Pinion Spigot End Number, PC-2	+ 0.002
Standard Shim Pack Thickness	0.032
New Bevel Pinion Spigot End Number, PC+5	+ 0.005
New Shim Pack Thickness	0.037
3.	
Old Shim Pack Thickness 0.030 Old Bevel Pinion Spigot End Number, PC+2	- <u>0.002</u>
Standard Shim Pack Thickness	0.028
New Bevel Pinion Spigot End Number, PC-5	- <u>0.005</u>
New Shim Pack Thickness	0.023
4.	
Old Shim Pack Thickness Old Bevel Pinion	0.030
Spigot End Number, PC-2	+ <u>0.002</u>
Standard Shim Pack Thickness New Pinion Cone Number, PC-5	0.032 - <u>0.005</u>
New Shim Pack Thickness	0.027

- 5. INSTALL BEVEL PINION (12) AND BEARING CAGE (28) AS AN ASSEMBLY, AND SHIM PACK (34) INTO THE CARRIER.
- 6. INSTALL BEARING CAGE COVER (30).
  - a. Install pinion bearing cage thrust washer (32) on bevel pinion (12).

t

- b. Place bearing cage cover (30) onto bearing cage (28) and secure with eight capscrews (29).
- c. Torque capscrews (29) to between 50 and 75 lb. ft.

## **NOTE**

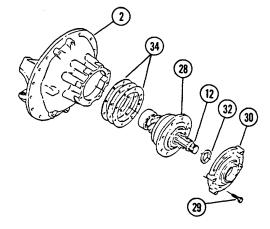
When installing capscrews (23) apply Loctite #277 to threads.

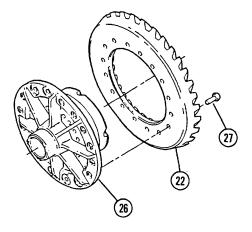
7. IF REMOVAL WAS NECESSARY, INSTALL RING GEAR (22).

#### **CAUTION**

Ring gear (22) must be heated before installation. Failure to heat ring gear (22) before installation could cause damage to differential case half (26) because of tight fit.

 a. Expand ring gear (22) by heating in a tank of water to a temperature of 1600F to 180°F for 10 to 15 minutes.





#### **WARNING**

Wear gloves and proper clothing while handling hot ring gear (22). Failure to follow this precaution could result in serious personal injury.

- b. Use a sling and hoist to lift the ring gear (22) from tank of water.
- c. Install ring gear (22) on flange case half (26) immediately after heating. If ring gear (22) does not fit easily on flange case half (26), repeat STEP a.
- d. Align fastener holes of ring gear (22) and flange case half (26) by rotating ring gear (22) as needed.
- e .Properly install twelve new rivets (27) in pairs opposite each other (A and B) from the flange case half (26) side of the assembly (side opposite gear teeth).

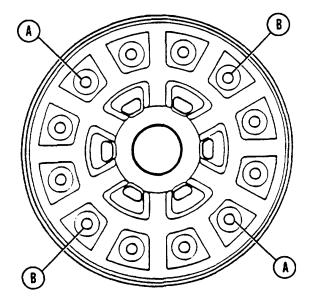
#### **CAUTION**

Do not heat rivets (27) before installation. Hot rivets (27) could damage ring gear (22) and flange case half (26).

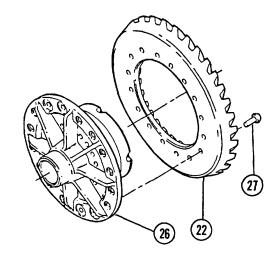
f. Use a riveting machine to press rivets (27) into place from ring gear (22) side of the assembly. Press rivets (27) in pairs opposite each other. Apply 60, 000 lb. of pressure.

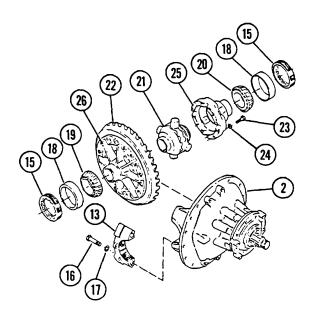
## **CAUTION**

Pressure on rivets (27) must be held for approximately one minute so that rivet body will completely fill hole. Failure to do so could cause rivet failure.



- g. Use a 0.003 inch feeler gauge to check for gaps between back surface of ring gear (22) and flange case half (26). If gauge fits more than half way to rivets, remove ring gear (22); see DISASSEMBLY STEP 3, a through d and repeat STEPS a through f. If gap persists, inspect flange case half (26) and ring gear (22) for problem, replace defective parts.
- h. Use a press and suitable sleeve to install bearing cone (19) on flange case half (26).
- i. Use a press and suitable sleeve to install bearing cone (20) on plain case half (25).
- Apply gear lubricant to inside surfaces of both case halves (25 and 26) and no-spin differential (21).
- k. Place flange case half (26) on bench, ring gear (22) teeth up.
- I. Install no-spin differential (21) into flange case half (26).
- m. Place plain case half (25) over flange case half (26) and no-spin differential (21). Rotate plain case half (25) as needed to align match marks.
- n. Apply Loctite #277 to eight capscrews (23). Install four of the eight capscrews (23) and four flatwashers (24) as opposing pairs (X and Y) into case halves (25 and 26).





## **CAUTION**

Spacing between four initially installed capscrews (23) must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

o. Torque four capscrews (23) to between 60 and 75 lb. ft.

#### **NOTE**

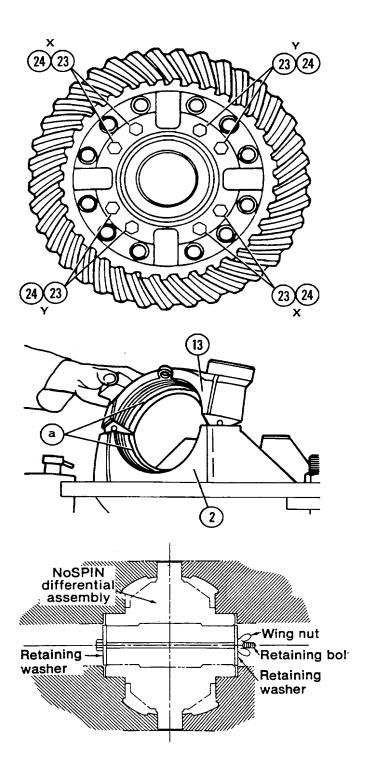
Torque capscrews (23) in pairs on opposing sides of ring gear (22).

- Install remaining four capscrews (23) and four flatwashers (24).
   Torque capscrews to between 60 and 75 lb. ft.
- q. Remove no spin retaining bolt, flatwashers, and wing nut.

## **NOTE**

When installing bearing cups (18), apply Loctite #277 to bearing bores of differential carrier (2) legs and bearing caps (13). Do not apply Loctite #277 to adjusting ring (15) threads.

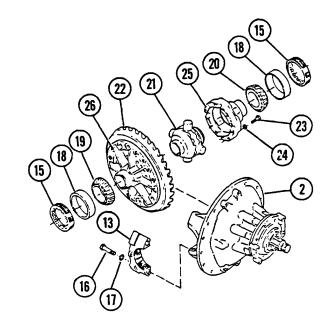
- 8. INSTALL DIFFERENTIAL AND RING GEAR ASSEMBLY.
  - a. Clean and dry bearing cups (18), bores of differential carrier(2) legs and bearing caps (13).
  - Apply thin film of gear oil to inner diameter of the bearing cups (18) and on both bearing cones (19 and 20).
  - c. Apply thin bead of Loctite #277
     to bearing bores (a) of differential
     carrier (2) legs and bearing
     caps (13). Do not apply Loctite
     #277 to adjusting ring (15)
     threads.



- d. Install two bearing cups (18) over bearing cones (19 and 20) on case halves (25 and 26).
- e. Use a sling and hoist to lift differential and ring gear (18-26) as an assembly and install into differential carrier (2). Bearing cups (18) must be flat against bores between differential carrier (2) legs.
- f. Install both bearing adjusting rings (15) into position between differential carrier (2) legs. Turn each adjusting ring (15) hand tight against bearing cup (18).
- g. Install bearing caps (13) over the assembled bearing cups (18) and bearing cones (19 and 20), and adjusting rings (15). Use match marks made during disassembly to match original location of bearing caps.
- h. Use a plastic or leather mallet to fit each bearing cap (13) tightly against the bearing cups (18), adjusting rings (15) and differential carrier (2) legs.
  If bearing caps (13) do not fit correctly, check alignment of match marks between bearing caps (13) and differential carrier (2) leg. If necessary, repeat STEPS f and g.
- Install two capscrews (16) and two flatwashers (17) that hold bearing caps (13) to differential carrier (2) legs. Tighten capscrews (16) by hand four to six turns, then torque to between 110 and 145 lb. ft.

#### **ADJUSTMENT**

 ADJUST PRELOAD OF DIFFERENTIAL BEARINGS (18-20).



- Attach a dial indicator on the mounting flange of the differential carrier (2).
- b. Adjust the dial indicator so that the plunger is against the back surface of the ring gear (22).

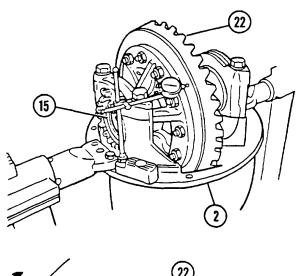
## **CAUTION**

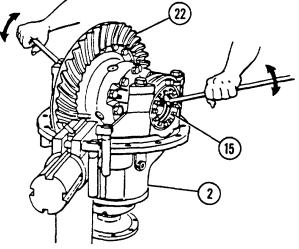
When turning bearing adjusting rings (15), always use a tool that engages two or more opposite notches in the ring. A large screwdriver can be used for this purpose. Failure to do so could cause damage to adjusting ring lugs.

- c. Loosen the bearing adjusting ring (15) opposite ring gear (22) so that a small amount of end play shows on dial indicator. Move differential assembly and ring gear (22) left and right with suitable pry bars while reading dial indicator. Do not allow pry bars to touch bearings (18-20).
- d. Tighten bearing adjusting ring (15) opposite ring gear (22) so that no end play shows on dial indicator. Move the differential assembly and ring gear (22) left and right as needed.
- e. Tighten each bearing adjusting ring (15) one notch from zero end play measured in STEP d.

## 2. CHECK RUNOUT OF RING GEAR (22).

- a. Attach dial indicator on mounting flange of differential carrier
   (2). Adjust dial indicator so that plunger is against back surface of ring gear (22).
- b. Adjust dial of indicator to zero.





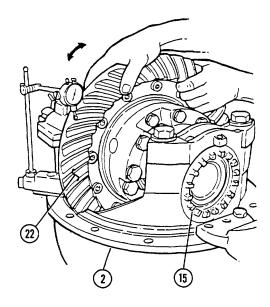
c. Rotate differential assembly and ring gear (22) and read dial indicator. If runout of ring gear (22) exceeds 0.008 inches, remove differential assembly and ring gear (22), DISASSEMBLY STEP 1, and inspect differential assembly for problem. Replace defective parts and reinstall differential assembly and ring gear (22) into differential carrier (2), ASSEMBLY STEP 8. Repeat preload adjustment of differential bearings, STEP 1.

## 3. ADJUST BACKLASH OF RING GEAR (22).

- Attach a dial indicator to the mounting flange on differential carrier (2).
- Adjust dial indicator so that plunger is against the tooth surface on ring gear (22).
- c. Adjust dial of indicator to zero.
- d. Hold bevel pinion in position.
- e. Read dial indicator while rotating ring gear (22) a small amount in both directions.
- f. Adjust backlash of old gear set to setting measured before carrier was disassembled (0.008 inch to 0.018 inch).
- g. If new gear set is installed, adjust backlash to 0.012 inch.

#### **NOTE**

When adjusting backlash, adjust only the ring gear (22); do not adjust the bevel pinion (12).



- h. Increase backlash by loosening bearing adjusting ring (15) opposite teeth of ring gear (22), and tightening bearing adjusting ring (15) on ring gear (22) side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.
- Decrease backlash by tightening bearing adjusting ring (15) opposite teeth of ring gear (22), and loosening bearing adjusting ring (15) on ring gear (22) side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.
- CHECK TOOTH CONTACT PATTERNS OF THE GEAR SET.

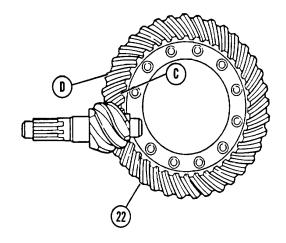
#### **NOTE**

In the following steps, movement of contact pattern in length of tooth is indicated as toward "toe" (C) or "heel" (D) of ring gear.

## **NOTE**

Always check tooth contact patterns on drive side of gear teeth.

- a. Apply marking compound (Prussian blue, red lead...) to 12 gear teeth of ring gear. Rotate ring gear so that 12 gear teeth are next to bevel pinion.
- b. Rotate ring gear (22) forward and backward so that 12 marked teeth go past bevel pinion 6 times to get contact patterns. Repeat, if necessary, to get a more clear pattern.

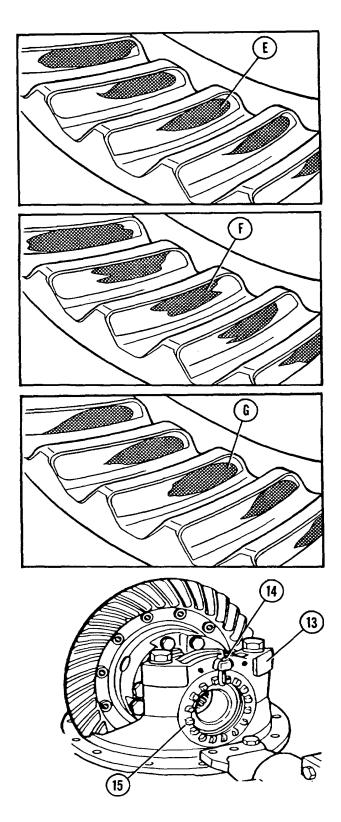


- c. Inspect contact patterns on ring gear (22). Good hand rolled pattern (E) will show contact toward toe of gear tooth and in the center between top and bottom of tooth. A high pattern (F) will show contact closer to top of gear tooth. A low pattern (G) will show contact toward bottom of gear tooth. When in operation, pattern will extend to approximately full length of gear tooth.
- d. If necessary, install thinner shim pack (34) under pinion bearing cage (28) to correct high contact pattern.
- e. If necessary, install thicker shim pack (34) under pinion bearing cage (28) to correct low contact pattern.
- f. If necessary, decrease backlash, STEP 3, i. to move contact patterns toward toe of ring gear teeth.
- g. If necessary, increase backlash, STEP 3, h. to move contact patterns toward heel of ring gear teeth.
- h. Install two new cotter pins (14)
   that hold two bearing adjusting
   rings (15) in position. Install
   cotter pins (14) through boss of
   bearing cap (13) and between lugs
   of adjusting ring (15).

## **INSTALLATION**

#### **NOTE**

Apply silicone RTV-732 clear sealing compound to mounting surface of axle housing (3) that fastens differential carrier (2).



1. INSTALL DIFFERENTIAL CARRIER (2) INTO AXLE HOUSING (3).

#### NOTE

Inside of axle housing and mounting flange where carrier fastens should be clean and dry before installing carrier.

a. Install companion flange (4), washer (5) and nut (6) onto bevel pinion (12).

## WARNING

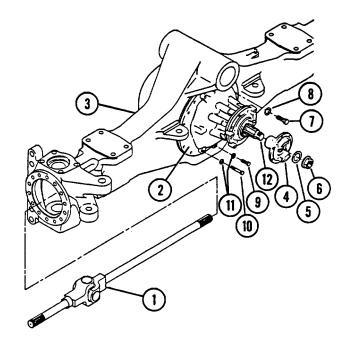
Minor concentrations of acetic acid may be produced during application of silicone RTV-732 clear sealing compound. Adequate ventilation should be provided when silicone RTV is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

- b. Apply a 1/8 inch bead of silicone RTV-732 clear sealing compound to mounting surface of axle housing (3) that differential carrier (2) fastens.
- c. Install differential carrier (2) into axle housing (3).

#### **CAUTION**

Four initially installed capscrews (7) must be evenly spaced to prevent uneven pressure on differential carrier (2) when torquing. Failure to do so could cause component failure.

d. Install four capscrews (7) and flatwashers (8) into corner locations around differential carrier (2) and axle housing (3). Hand tighten.



e. Carefully push differential carrier (2) into position. Tighten four capscrews (7) two or three turns each in a pattern opposite each other.

#### **NOTE**

Torque capscrews (7) in pairs on opposing sides of differential carrier (2).

- f. Torque capscrews (7) to between 50 and 75
   lb. ft. Torque in pairs across from each other.
- g. Install remaining eight capscrews (7), two capscrews (9), two capscrews (10), four flatwashers (11) and eight flatwashers (8).Be sure fasteners are in correct location as noted during disassembly.
- h. Install axle shafts (1) into axle housing (3).
- i. Carefully tip axle housing (3) upright.
- 2. INSTALL FRONT PLANETARY WHEEL ENDS, PARA. 8-6.
- 3. FILL AXLE HOUSING WITH LUBRICANT, TM10-3930-660-20.
- 4. INSTALL WHEEL ASSEMBLIES, TM10-3930-660-20.
- 5. INSTALL FRONT AXLE ASSEMBLY ON VEHICLE, PARA. 8-3.

#### 8-6. FRONT PLANETARY WHEL ENDS - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

### **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Lifting Device (Capacity 2000 lb.)

Fabricated Tool - Hub Drag Tool (App. C, Fig. C-4)

4 inch by 4-1/2 inch deep six-point socket

## **Equipment Condition**

Front of vehicle raised 8 inches and supported under front axle, TM10-3930-660-20. Planetary wheel ends drained, L010-3930-660-12.

## Materials/Parts

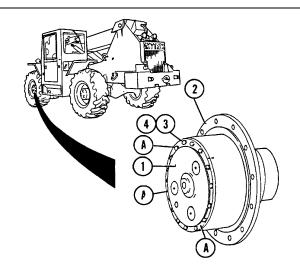
Gear Lubricant (App. B, Item 32) Lint-Free Rags (App. B, Item 38) Oil Pan RTV-732 Clear Sealing Compound (App. B, Item 7) Snap Ring (5, 9)

Wheel assemblies removed, TM10-3930-660-20. Front disc brake assemblies removed, para. 10-3.

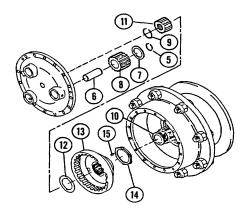
## **REMOVAL**

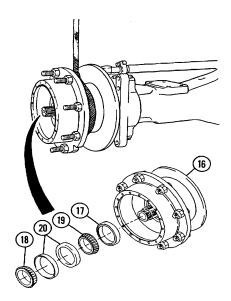
#### REMOVE PLANETARY GEAR ASSEMBLY.

- a. Mark planetary spider (1) and wheel hub (2) for correct-alignment during installation.
- b. Place a suitable container under planetary wheel end assembly.
- c. Remove sixteen capscrews (3) and sixteen flatwashers (4) from planetary spider (1).
- d. Use three capscrews (3) in jack screw holes (A) and tighten to remove planetary spider (1).



- 2. DISASSEMBLE PLANETARY SPIDER ASSEMBLY (6-8).
  - a. Remove and discard three snap rings (5) from planetary pinion shafts (6).
  - b. Remove three thrust washers (7) and planetary gears (8) from planetary pinion shafts (6).
- 3. REMOVE PLANETARY SUN GEAR (11) AND RING GEAR (13).
  - a. Remove and discard snap ring (9) from end of wheel bearing spindle (10).
  - b. Remove planetary sun gear (11).
  - c. Remove sun gear thrust washer (12).
  - d. Remove planetary ring gear (13).
- 4. REMOVE WHEEL HUB AND DISC ASSEMBLY (16).
  - Use a sling and hoist or other suitable lifting device to support hub weight during removal.
  - b. Remove hub bearing nut (14). If necessary, remove dowel pin (15).
  - c. Wobble wheel hub and disc assembly (16) to unseat oil seal (17), inner (19) and outer (18) bearing cone.
  - d. Remove outer bearing cone (18).
  - e. Remove wheel hub and disc assembly (16).
  - f. Remove inner oil seal (17).
  - g. Remove inner bearing cone (19).
  - h. If necessary, remove two bearing cups (20) with a suitable puller.





## 5. REMOVE SPINDLE ASSEMBLY.

 Remove ten spindle capscrews (21), four shorter capscrews (22), and fourteen flatwashers (23).

## **CAUTION**

Inner oil seal (25) and bushing (24) in bore of spindle can be damaged when sliding spindle past axle splines. Remove spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure.

- b. Remove wheel bearing spindle (10).
- c. Remove oil seal (25).
- d. If necessary, remove bushing (24).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### INSPECTION

See Inspection Instructions, para. 2-11.

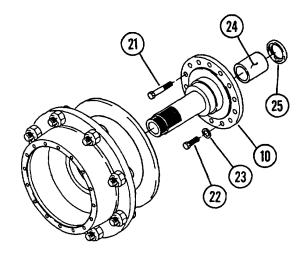
#### **INSTALLATION**

- 1. ASSEMBLE SPINDLE (10).
  - If removed, push bushing (24) into spindle (10) until top of bushing is flush or just below bottom of bore for seal (25).
  - b. Push seal (25) to bottom of bore.
- 2. INSTALL SPINDLE ASSEMBLY.
  - Apply a thin film of gear lubricating oil to lips of oil seal (25) in spindle (10) bore, bore of bronze bushing (24) in spindle and oil seal journal on axle shaft short end.

8-35

TM 10-3930-660-34

# 8-6. FRONT PLANETARY WEKEL ENDS - REPLACE (Cont'd)



#### **CAUTION**

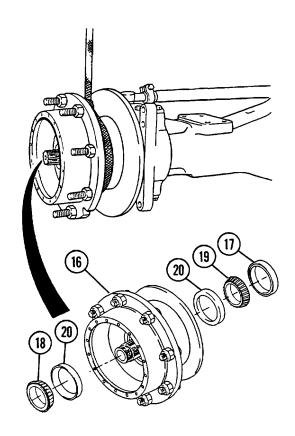
Inner oil seal (25) and bushing (24) in bore of spindle (10) could be damaged when sliding spindle past axle splines. Install spindle carefully to avoid damaging bushing inner oil seal (25). Failure to do so could cause premature component failure.

b. Install spindle (10).

#### NOTE

Install two shorter capscrews (22) at two top holes and two capscrews (22) at bottom two holes.

- c. Install ten capscrews (21), four shorter capscrews (22), and fourteen flatwashers (23) to secure wheel bearing spindle (10).
  Torque capscrews (21 and 22) to 150 lb. ft.
- 3. INSTALL WHEEL HUB AND DISC ASSEMBLY (16).
  - a. Install two bearing cups (20) with a suitable driving sleeve into wheel hub.
  - b. Place wheel hub and disc assembly (16) on floor or bench with the brake disc up.
  - c. Apply a thin film of gear lubricating oil to inner bearing (19) and install in inner bearing cup (20).
  - d. Install oil seal (17) with a suitable driver.
  - Use a sling and hoist or other suitable lifting device to support weight of wheel hub and disc assembly (16).



- f. Apply a thin film of gear lubricating oil to inside diameter of oil seal (17) and to oil seal journal surface of wheel bearing spindle (10).
- g. Align wheel hub and disc assembly (16) with wheel bearing spindle (10). Push wheel hub and disk assembly (16) onto spindle (10).
- h. Install outer bearing cone (18) in outer bearing cup (20).
- Install hub bearing nut (14) and draw wheel hub and disc assembly (16) into position while rotating wheel hub.

## 4. PRELOAD WHEEL BEARINGS.

- a. Seat bearings and related components by tightening the hub bearing nut (14) to 100 lb. ft. while hub is rotated in both directions.
- b. Back off hub bearing nut (14) to relieve preload on bearings. Torque on nut should be 0 lb. ft.
- Use fabricated hub drag tool and a torque wrench to check rolling torque while hub is rotating at a steady rate (not starting torque). Record torque.
- d. Tighten hub bearing nut (14) and check hub rolling torque again. <u>Increase</u> in rolling torque from zero preload, should be 3 to 5 lb. ft. for new bearings.

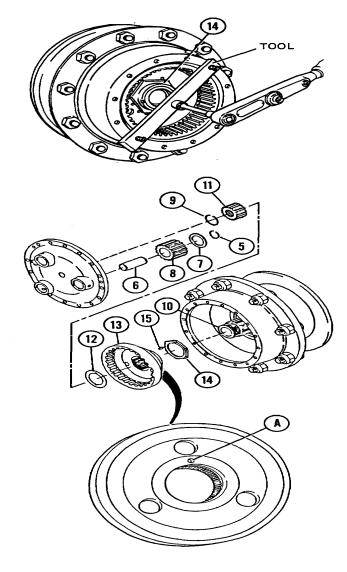
#### **NOTE**

If bearings are to be reused, the increase in rolling torque should be 1.5 to 2.5 lb. ft.

- 5. INSTALL PLANETARY RING GEAR (13) AND SUN GEAR (11).
  - a. Install dowel pin (15), if removed.
  - b. Locate hole (A) on back of planetary ring gear (13). Orient ring gear (13) with respect to dowel pin (15) on wheel hub bearing nut (14).

#### **NOTE**

If pin (15) is not aligned with hole A of ring gear, spider assembly (1) will not fit tight to wheel hub.



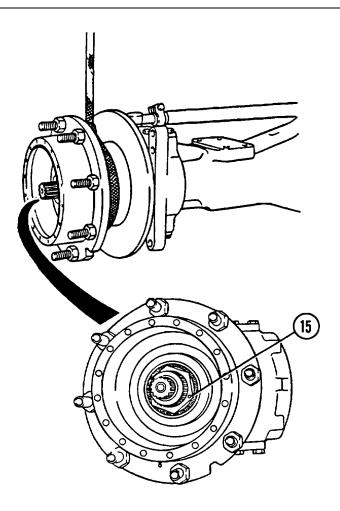
- c. Install planetary ring gear (13). It may be necessary to turn hub bearing nut (14) to match hole (A) on back of planetary ring gear (13). Hub bearing nut (14) may be tightened to match dowel pin (15) with planetary ring gear, but torque on hub bearing nut (14) should not exceed 150 lb. ft.
- Install sun gear thrust washer (12), sun gear (11) and new spindle snap ring (9). Tangs on thrust washer (12) must engage slots in ring gear (13).

## 6. ASSEMBLE PLANETARY SPIDER.

- a. Apply a thin film of gear lubricating oil to bore of planetary gear (8). Slide planetary gear (8) and outer thrust washer (7) onto planetary pinion shaft (6).
- Install new snap ring (5) onto planetary pinion shaft (6).
- Repeat STEPS a and b for second and third sets of planetary gears (8), thrust washers (7) and snap rings (5).

## 7. INSTALL PLANETARY GEAR ASSEMBLIES.

- Remove dirt, grease or moisture from the mating surfaces of the spider flange and hub mounting face.
- b. Dry both surfaces.



#### WARNING

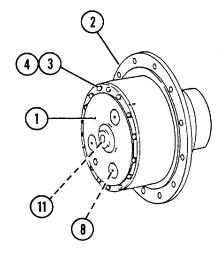
Adequate ventilation must be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

c. Apply a continuous bead of silicone RTV-732 clear sealing compound approximately 1/8 inch in diameter completely around the hub mounting face and around the inner edge of all fastener holes to assure complete sealing and prevent leakage.

## NOTE

Assemble components immediately to permit silicone RTV-732 clear sealing compound to spread evenly. Failure to do so could cause axle to leak.

- d. Start planetary spider (1) onto wheel hub(2), aligning teeth of planetary gears (8)with sun gear (11) and ring gear (13) teeth.
- Align the match marks on the spider flange and wheel hub as previously marked during removal.
- f. Align holes on wheel hub (2) with holes on planetary spider (1) flange and push spider assembly against hub (2).
- g. Install sixteen capscrews (3) and flatwashers (4).
- h. Tighten capscrews (3) and torque to 60-75 lb. ft.



- 8. FILL PLANETARY WHEEL ENDS WITH LUBRICANT, L010-3930-660-12.
- 9. INSTALL FRONT DISC BRAKE ASSEMBLY, PARA. 10-3.
- 10. INSTALL WHEEL ASSEMBLY, TM10-3930-660-20.

8-39/(8-40 Blank)

## **CHAPTER 9**

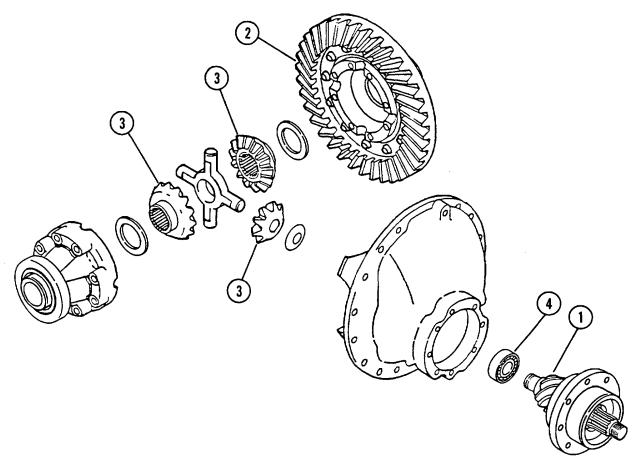
### **REAR AXLE MAINTENANCE**

#### Section I. DESCRIPTION AND DATA

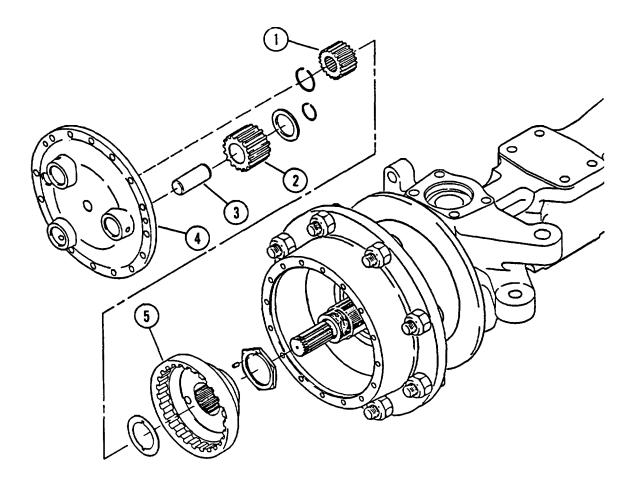
#### 9-1. GENERAL.

Front axle maintenance procedures not covered in this section may be found in TM10-3930-660-20.

## 9-2. PRINCIPLES OF OPERATION.



a. <u>Differential</u>. The rear differential provides the primary drive gear reduction. It is a single reduction carrier and is manufactured by Rockwell. This carrier has a bevel drive pinion (1) and ring gear (2) set and bevel gears (3) in the differential assembly. A straight roller (spigot) bearing (4) is mounted on the head of the drive pinion (1). All other bearings in the carrier are tapered roller bearings. When the carrier operates, there is normal differential action between the wheels all the time.



b. <u>Planetary Wheel Ends</u>. The planetary wheel ends provide the second gear reduction at the wheel hub. Planetary axles permit the bevel gearing of the carrier, and the axle shafts to carry nominal torsional load while providing the highest practical numerical gear reduction at the wheels.

The spur teeth of the planetary sun gear (1) mesh with teeth of the planetary gears (2). The planetary gears rotate on planetary pinion shafts (3) which are mounted on the planetary cover (4). The planetary gear (2) teeth, in turn, mesh with the teeth of the planetary ring gear (5).

Power is transmitted through the axle shafts to the sun gear, through the revolving planetary gears (1 and 2) and into the planetary cover (4) which drives the wheel hub.

# Section II. REAR AXLE MAINTENANCE PROCEDURES

#### **REAR AXLE MAINTENANCE TASK SUMMARY**

TASK PARA.	PROCEDURES	PAGE NO.
9-3	Rear Axle Assembly - Replace/Repair	9-3
9-4	Axle Pivot Pin - Replace	9-8
9-5	Rear Differential Carrier Assembly - Replace/Repair/Adjust	9-9
9-6	Rear Planetary Wheel Ends - Replace	9-32

#### 9-3. REAR AXLE ASSEMBLY - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

## **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Floor Jack, 10 Ton

Two Jackstands, 40 Inch Height Capacity, 7000 Lb. Minimum Capacity

Cap and Plug Set

## **Equipment Condition**

Rear propeller shaft removed, TM10-3930-660-20. Rear wheel assemblies removed, TM10-3930-660-20. Rear disc brake assemblies removed, para. 10-3. Counterweight removed, TM10-3930-660-20.

## Materials/Parts

Container Gear Oil (App. B, Item 32) Lint-Free Rags (App. B, Item 38) Locknut (4) Tags (App. B, Item 52) Wood Blocks

# Personnel Required

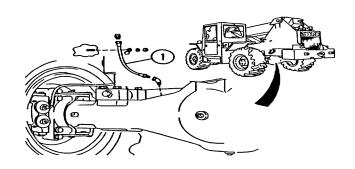
Two Personnel

#### **REMOVAL**

1. DISCONNECT AXLE BREATHER HOSE (1) FROM FRAME.

## **CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.



## 9-3. REAR AXLE ASSEMBLY - REPLACE/REPAIR (Cont'd)

#### **NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.

2. DISCONNECT AND PLUG REAR STEERING CYLINDER HYDRAULIC SUPPLY HOSES (2).

#### NOTE

Weight of axle assembly is 1, 650 lbs.

#### **NOTE**

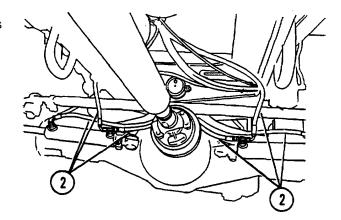
Do not raise frame off jackstands.

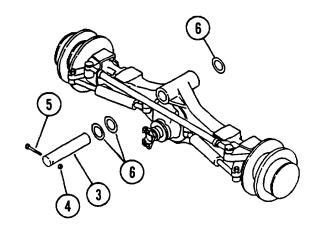
- USE A FLOOR JACK TO SUPPORT WEIGHT OF REAR AXLE ASSEMBLY.
- 4. REMOVE AXLE PIVOT PIN (3).
  - Remove locknut (4) and retaining bolt (5).
     Discard locknut (4).

## **NOTE**

Note the location and quantity of washer spacers (6) during disassembly. Keep washer spacers (6) together as a set. Do not mix washer spacers (6) sets.

- b. Remove axle pivot pin (3) and washer spacers (6).
- 5. REMOVE AXLE ASSEMBLY.
  - Lower floor jack until top of axle housing is clear of frame and exhaust pipe. Carefully pull jack supporting axle assembly from under vehicle while assistant holds axle assembly steady.
  - Support axle assembly using suitable stands or blocks.





## 9-3. REAR AXLE ASSEMBLY - REPLACE/REPAIR (Cont'd)

## **NOTE**

Repair of axle assembly at Direct Support is limited to replacement of axle seals, steering knuckle bushings, and pivot bushings.

#### **DISASSEMBLY**

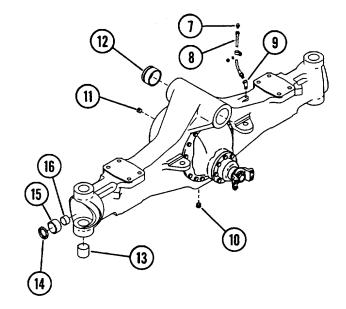
- 1. REMOVE TIE ROD, TM10-3930-660-20.
- 2. REMOVE STEERING CYLINDERS, TM10-3930-660-20.
- 3. REMOVE REAR PLANETARY WHEEL ENDS, PARA. 9-6.
- 4. REMOVE REAR DIFFERENTIAL CARRIER ASSEMBLY AND REAR UNIVERSAL (CARDAN) STEERING JOINTS, PARA. 9-5.
- 5. REMOVE STEERING KNUCKLES, PARA. 12-3.
- 6. IF NECESSARY, REMOVE FOLLOWING PARTS:
  - a. Breather (7), hose (8), and elbow (9).
  - b. Drain plug (10).
  - c. Oil filler plug (11).
  - d. Two bearings (12).
  - e. Four king pin bushings (13).
  - f. Two oil seals (14).
  - g. Two sleeves (15) and two bushings (16).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

## **INSPECTION**

See Inspection Instructions, para. 2-11.



9-5

TM 10-3930-660-34

## 9-3.REAR AXLE ASSEMBLY - REPLACE/REPAIR (Cont'd)

#### 1.IF REMOVED, INSTALL FOLLOWING PARTS:

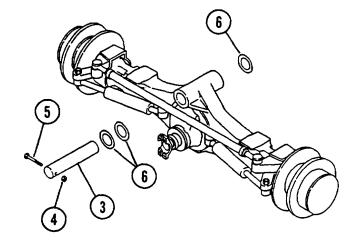
- a. Two bushings (16) and two sleeves (15).
- b. Two oil seals (14).
- c. Four king pin bushings (13).
- d. Two bearings (12).
- e. Oil filler plug (11).
- f. Oil drain plug (10).
- g. Breather (7), hose (8), and elbow (9).
- 2. INSTALL REAR STEERING KNUCKLES, PARA. 12-3.
- 3. INSTALL REAR DIFFERENTIAL CARRIER ASSEMBLY AND REAR UNIVERSAL (CARDAN) STEERING JOINTS, PARA. 9-5
- 4. INSTALL REAR PLANETARY WHEEL ENDS, PARA. 9-6.
- 5. INSTALL STEERING CYLINDERS, TM10-3930-660-20.
- 6. INSTALL TIE RODS, TM10-3930-660-20.

#### **INSTALLATION**

#### **NOTE**

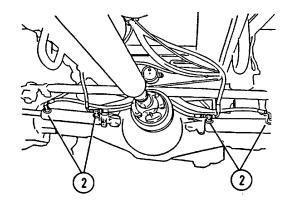
At least one washer spacer (6) must be installed on each side of axle pivot hole.

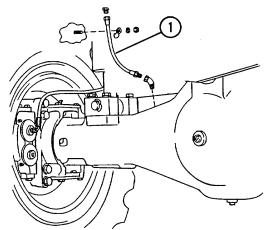
- 1. PLACE WASHER SPACERS (6) ON FRAME PIVOT PIN HOLES; USE THIN FILM OF GREASE TO RETAIN WASHER SPACERS (6).
- 2. INSTALL AXLE ASSEMBLY AND ALIGN WITH FRAME PIVOT PIN HOLES.



## 9-3.REAR AXLE ASSEMBLY - REPLACE/REPAIR (Cont'd)

- a. Place floor jack under center of axle assembly. Use floor jack to raise axle assembly. Have assistant hold axle assembly steady.
- b. Remove stands or blocks.
- c. Lower floor jack to allow axle assembly to clear frame.
- d. Carefully move axle under vehicle with jack and position axle pivot hole in line with frame pivot holes.
- Use floor jack to carefully raise axle assembly while assistant holds assembly steady. Keep shims (6) in position.
- f. Raise floor jack until axle pivot pin hole is aligned with frame pivot pin holes.
- 3. INSTALL PIVOT PIN (3).
  - a. Secure rear axle to frame with axle pivot pin (3).
  - b. Secure axle pivot pin with retaining bolt (5) and new locknut (4). Torque bolt (5) to 100 lb. ft.
- 4. INSTALL REAR PROPELLER SHAFT, TM10-3930-660-20.
- 5. INSTALL REAR DISC BRAKE ASSEMBLIES, PARA. 10-3.
- 6. INSTALL REAR WHEEL ASSEMBLIES, TM10-3930-660-20.
- USE A FLOOR JACK TO RAISE REAR OF VEHICLE UNTIL VEHICLE FRAME CLEARS JACKSTANDS. REMOVE JACKSTANDS AND CAREFULLY LOWER VEHICLE.
- 8. CONNECT REAR STEERING CYLINDER HYDRAULIC SUPPLY HOSES (2).





- 9. CONNECT AXLE BREATHER HOSE (1) TO FRAME.
- 10. INSTALL COUNTERWEIGHT, TM 10-3930-660-20.

#### 9-4. AXLE PIVOT PIN - REPLACE

#### This task covers:

- a. Removal
- b. Installation

## **Initial Setup**

**Tools** 

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power Materials/Parts Locknut (2) Wood Blocks

Personnel Required
Two Personnel

## **Equipment Condition**

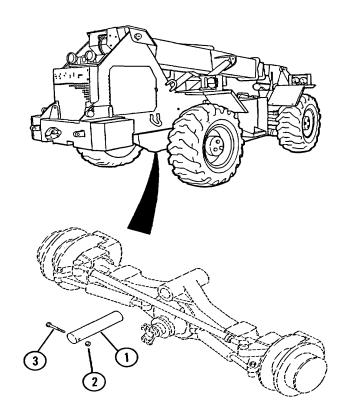
Vehicle parked on level surface, park brake set.

#### **REMOVAL**

- RAISE VEHICLE BY THE FRAME SO THAT WEIGHT OF VEHICLE IS OFF PIVOT PIN (1). DO NOT RAISE VEHICLE OFF GROUND.
- 2. SUPPORT VEHICLE UNDER FRAME USING SUITABLE STANDS.
- 3. REMOVE LOCKNUT (2) AND RETAINING BOLT (3).DISCARD LOCKNUT (2).
- 4. REMOVE AXLE PIVOT PIN (1).

# **INSTALLATION**

- 1. INSTALL AXLE PIVOT PIN (1).
- 2. INSTALL RETAINING BOLT (3) AND NEW LOCKNUT (2).
- 3. TORQUE RETAINING BOLT (3) TO 100 LB. FT.
- 4. RAISE VEHICLE AND REMOVE STANDS.
- 5. LOWER VEHICLE.



#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Adjustment
- g. Installation

# Initial Setup

#### **Tools**

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair, Common 1 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Fabricated Tool - Differential Resistance Tool (App. C, Fig. C-3)

Fabricated Tool - Yoke Nut Tool (App. C, Fig. C-5)

Lifting Device, Capacity 2 Ton

**Bearing Puller** 

Dial Indicator

## **Equipment Condition**

Rear axle assembly, removed, para. 9-3.
Axle housing lubricant, drained, TM-10-3930-660-20.
Rear planetary wheel ends removed, para. 9-6.

Torque Wrench, 600 Lb. Ft.

Torque Wrench, 300 Lb. Ft.

Torque Wrench, 175 Lb. Ft.

Micrometer

Breaker Bar, 3/4 Inch Drive

**Arbor Press** 

Bearing Sleeve, 66 mm ID x 1 In. Deep

Soft Jaws for Vice

Adapter, 1/2 to 3/4 In. Drive

Socket, 1-5/16 In., 3/4 In. Drive

#### Materials/Parts

Cotter Pins (11)
Gear Lubricant (App. B, Item 32)
Loctite #277 (App. B, Item 44)
Oil Pan
Prussian Blue Marking Compound
(App. B, Item 6)
Rivets (28)
RTV-732 Clear Sealing Compound
(App. B, Item 7)
Wood Blocks

#### Personnel Required

Two Personnel

#### **REMOVAL**

- 1. REMOVE AXLE SHAFTS (1).
- 2. REMOVE DIFFERENTIAL CARRIER (2) FROM AXLE HOUSING (3).
  - a. Carefully tip axle assembly so that rear differential carrier (2) is up.

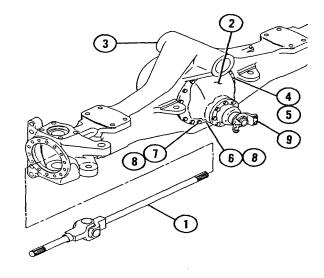
#### NOTE

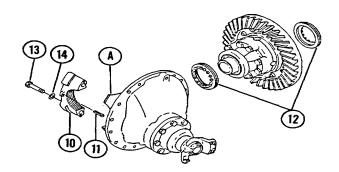
Capscrews from differential carrier (2) to axle housing (3) are of three different sizes. Note size, location and quantity of capscrews when removing for correct location during replacement.

- b. Remove twelve capscrews (4), twelve flatwashers (5), two capscrews (6), two capscrews (7) and four flatwashers (8) from differential carrier (2).
- c. Use a sling placed around the bevel pinion, behind companion yoke (9) to lift and support the differential carrier (2) during removal.
- d. Use a leather or rubber mallet to loosen the differential carrier (2) in the axle housing.
- e. Carefully remove the differential carrier (2) from the axle housing (3).
- Place differential carrier (2) on suitable stand or bench with ring gear up and clamp securely.

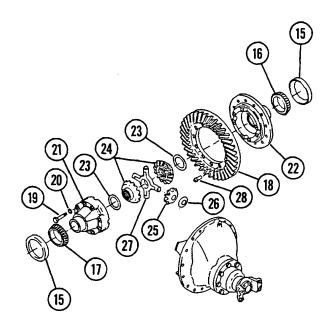
#### **DISASSEMBLY**

- 1. REMOVE DIFFERENTIAL AND RING GEAR ASSEMBLY FROM CARRIER (2).
  - a. Use a center punch and hammer to mark one carrier leg (A) and bearing cap (10) to enable correct matching at reassembly.

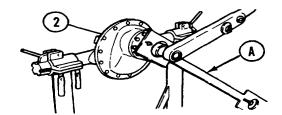


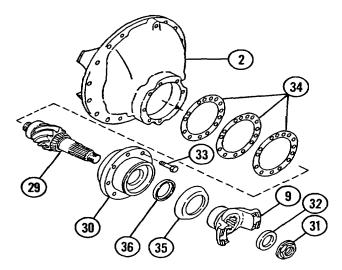


- b. Remove cotter pins (11) holding two bearing adjusting rings (12)in position. Discard cotter pins(11).
- c. Remove two capscrews (13) and two flatwashers (14) from each of two bearing caps (10).
- d. Remove two bearing caps (10), two bearing adjusting rings (12) and two bearing cups (15).
- e. Use a sling to lift the differential and ring gear assembly from the carrier. Place the assembly on a work bench.
- f. Remove flange case half bearing cone (16) and plain case half bearing cone (17) with a suitable puller.
- 2. DISASSEMBLE DIFFERENTIAL AND RING GEAR (18) ASSEMBLY.
  - a. If matching marks on the case halves of the differential are not visible, mark each case half with a center punch and hammer. The match marks are to ensure proper case halves orientation at assembly.
  - b. Remove eight capscrews (19) and eight flatwashers (20) from plain case half (21).
  - c. Separate the case halves (21 and 22).
  - d. Remove two side gear thrust washers (23), two side gears (24), four pinion gears (25), four pinion gear thrust washers (26), and differential spider (27).
- 3. IF NECESSARY, REMOVE RING GEAR (18).



- Inspect ring gear (18) for wear or damage. If ring gear (18) needs replacement, center punch twelve rivets (28) on side of ring gear (18).
- Drill twelve rivets (28) on ring gear (18) to a depth equal to thickness of one rivet head. Use a drill bit 1/32 of an inch smaller than rivet body diameter.
- Press or drive twelve rivets (28) from drilled side through holes in ring gear (18) and flange case half (22). Discard rivets (28).
- d. Support assembly under ring gear (18) with blocks and use a press to remove case half (22) through ring gear (18).
- 4. REMOVE BEVEL PINION (29) AND BEARING CAGE (30) FROM DIFFERENTIAL CARRIER (2).
  - Place differential carrier (2) on bench and clamp carrier securely.
  - Fasten a fabricated yoke nut tool (App. B, Fig. C-7) to companion yoke. Hold fabricated yoke nut tool (A) to remove bevel pinion nut (31) and washer (32).
  - c. Remove companion yoke (9) with deflector (35). Use a puller if necessary.
  - d. Remove eight capscrews (33).

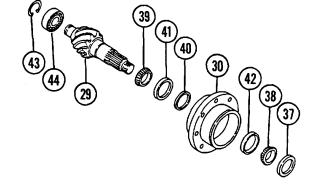




e. Remove bevel pinion (29), bearing cage (30) and shims (34), as an assembly, from the differential carrier (2). Keep shims together for use during assembly. If shims are damaged, measure total thickness of shim pack and record dimension; discard shims (34). Shim thickness dimension will be needed to calculate depth of bevel pinion in differential carrier when gear set is installed.

# 5. DISASSEMBLE BEVEL PINION (29) AND BEARING CAGE (30).

- a. Use a suitable puller to remove pinion oil seal (36) from bearing cage (30).
- b. Remove pinion bearing cage thrust washer (37).
- c. Place bevel pinion (29) and bearing cage (30) in a press with splined end of pinion at the top of assembly.
- Support bearing cage (30) under flange area with blocks.
- e. Use a press to remove bevel pinion (29) from bearing cage (30).
- f. Remove outer bearing cone (38) from bearing cage (30).
- g. Use a suitable puller to remove inner bearing cone (39) and bearing spacer (40) from bevel pinion (29).
- h. Use a suitable puller to remove inner bearing cup (41) and outer bearing cup (42) from bearing cage (30).



9-13

- i. Install a soft metal cover over vise jaws to protect bevel pinion (29). Place bevel pinion (29) in a vise.
- j. Use expanding snap ring pliers to remove snap ring (43) from end of bevel pinion (29).
- k. Use a suitable puller to remove bearing (44) from spigot end of bevel pinion (29).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

## **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

#### NOTE

Pinion and ring gears are a matched set. If replacement of ring gear or pinion gear is necessary, replace both gears as a set.

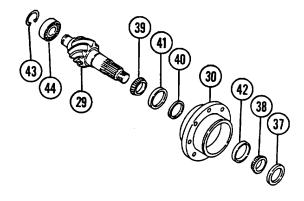
- 1. ASSEMBLE BEVEL PINION (29), BEARINGS (38, 39, 41 AND 42) AND BEARING CAGE (30).
  - a. Use a press and suitable driver to install inner bearing cup (41) and outer bearing cup (42) into bearing cage (30). Be sure bearing cups are tight against bottom of cage bore.
  - b. Use a press and suitable sleeve driver to install inner bearing cone (41) on bevel pinion (29).
  - c. If necessary, use a press and suitable sleeve driver to install spigot bearing (44) onto spigot end of bevel pinion (29).

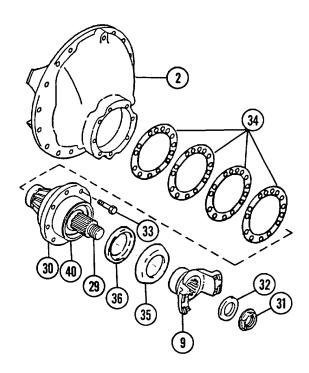
- d. Use an expanding snap ring pliers to install snap ring (43) into groove on end of bevel pinion (29).
- e. Apply a thin film of gear lubricant to inner and outer bearing cups (41 and 42) and bearing cones (38 and 39).
- f. Install bearing spacer (40) on bevel pinion against inner bearing cone (39).
- g. Install bevel pinion (29) and bearing assembly into bearing cage.
- h. Use a press and suitable sleeve driver to install outer bearing cone (38) on bevel pinion tight against bearing spacer (40).
- i. Install pinion bearing thrust washer (37).
- 2. ADJUST PRELOAD OF BEARINGS (38, 39, 41 AND 42) ON BEVEL PINION (29).
  - a. Install companion yoke (9), nut (31) and washer (32) on bevel pinion (29). If necessary, use a press to push yoke on pinion. Companion yoke (9) must be against thrust washer (37).

# **NOTE**

Shims (34) are not installed at this time.

b. Temporarily install bevel pinion (29) and bearing cage (30) assembly in differential carrier (2). Do <u>not</u> install shims (34) under bearing cage (30).



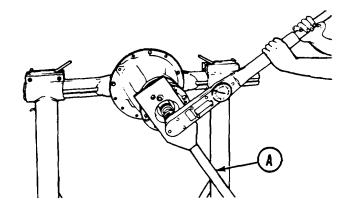


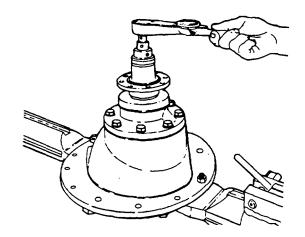
- c. Install eight capscrews (33) finger tight.
- d. Fasten a fabricated yoke nut tool
  (App. B, Fig, C-5) to companion yoke
  (9). Use a fabricated yoke nut tool
  (A) to hold bevel pinion (29) in position when nut (31) is tightened.
- e. Torque nut (31) on bevel pinion (29) to 300 400 lb . ft.
- f. Remove bar from companion yoke (9).

#### **NOTE**

Do not read starting torque. Read only torque value after bevel pinion (29) starts to rotate. Starting torque will give a false reading.

- g. Attach a lb . in . torque wrench on bevel pinion nut (31) . Rotate bevel pinion (29) and read value indicated on torque wrench . New pinion bearings should be preloaded between 5 and 45 lb. in . of torque . Reused pinion bearings should be preloaded between 10 and 30 lb . in.
- 1) Increase bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thinner bearing spacer (40). Repeat STEPS a. through g.
- 2) Decrease bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thicker bearing spacer (40). Repeat STEPS a. through g.

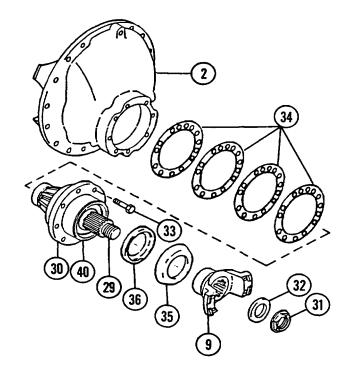


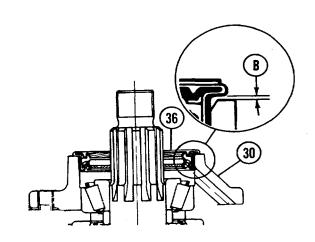


- h. Remove nut (31), washer (32) and companion yoke (9) from bevel pinion (29).
- i. Remove eight capscrews (33).
- j. Remove bevel pinion (29) and bearing cage (30), as an assembly, from differential carrier (2).

## 3 INSTALL PINION OIL SEAL (36).

- Apply a thin film of gear lubricant to inner surface of pinion oil seal (36).
- b. Apply a thin film of gear lubricant to seal bore in pinion bearing cage (30).
- Use a press or mallet and suitable sleeve to install bevel pinion bearing oil seal (36) into pinion bearing cage (30) until flange of seal is against bearing cage.
- d. Gap (B) of 0.015 0.030 inch is normal between seal (36) and bearing cage (30) . Check gap at several points . The difference between the largest and smallest gap measurement must not exceed 0.010 inch.
- e. Install companion yoke (9) with deflector (35), washer (32) and nut (31).
- 4. ADJUST THICKNESS OF SHIM PACK FOR NEW BEVEL PINION (29) AND RING GEAR (18) SET.





#### NOTE

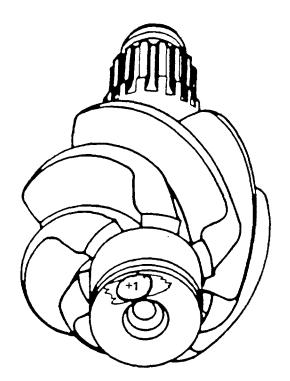
If a new bevel pinion (29) and ring gear (18) set is installed, or if the depth of the bevel pinion (29) has to be adjusted, calculate the needed thickness of the shim pack using the following procedure:

- a. Use a micrometer to measure thickness of old shim pack (34) removed from under bearing cage (30) . Record measurement.
- b. Read cone variation number on spigot end of old bevel pinion(29) . Record number.

#### **NOTE**

Bevel pinion spigot end number can be in 1,000ths of an inch or 100ths of a millimeter . Millimeters will be indicated with a decimal point . Example: +3 = .003 inch , +.03 = .03mm . Be sure to convert millimeters to inches by multiplying by 0.039 before performing the following calculations:

- c. If old bevel pinion cone number is a plus (+) value, subtract number from shim pack (34) thickness measured in STEP a. If old bevel pinion cone number is a minus (-) value, add number from spigot end of old bevel pinion (29) to shim pack (34) thickness. This is the thickness of the standard shim pack, without a cone variation.
- d. Read number on spigot end of new bevel pinion (29) . Record number.

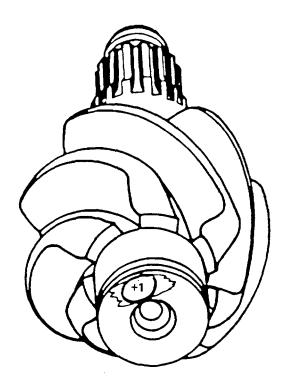


- e. If number on spigot end of new bevel pinion is a plus (+), add number to standard shim pack (34) thickness calculated in STEP c . If new pinion cone number is a minus (-), subtract new pinion cone number from standard shim pack (34) thickness calculated in STEP
- c. This is the thickness of the new shim pack with cone variation

## **EXAMPLES**:

1.

Old Shim Pack Thickness Old Bevel Pinion		0.030
Spigot End Number , PC+2	-	0.002
Standard Shim Pack Thickness New Beyel Pinion		0.028
Spigot End Number , PC+5	+	<u>0.005</u>
New Shim Pack Thickness		0.033
2.		
Old Shim Pack Thickness Old Bevel Pinion		0.030
Spigot End Number , PC-2	+	0.002
Standard Shim Pack Thickness New Bevel Pinion		0.032
Spigot End Number , PC+5	+	0.005
New Shim Pack Thickness		0.037
3.		
Old Shim Pack Thickness Old Bevel Pinion		0.030
Spigot End Number , PC+2	-	0.002
Standard Shim Pack Thickness New Bevel Pinion		0.028
Spigot End Number , PC-5	-	<u>0.005</u>
New Shim Pack Thickness		0.023



4.

Old Shim Pack Thickness		0.030
Old Bevel Pinion Spigot End Number, PC-2	+	0.002
Standard Shim Pack Thickness New Pinion Cone Number, PC-5	-	0.032 <u>0.005</u>
New Shim Pack Thickness		0.027

5 . INSTALL BEVEL PINION (29) AND BEARING CAGE (30) , AS AN ASSEMBLY , AND SHIM PACK (34) INTO THE CARRIER.

## NOTE

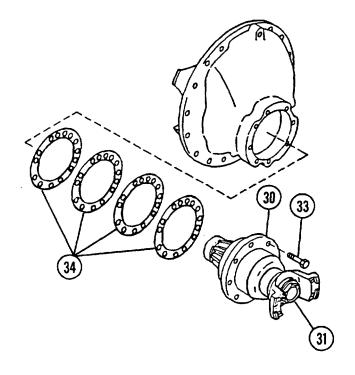
Use a minimum of three shims in a shim pack . Install the thinnest shims on both sides of the shim pack for maximum sealing.

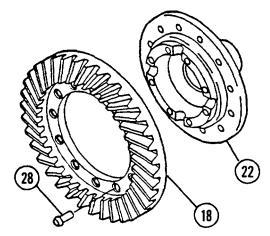
- a. Install shim pack (34) and pinion bearing cage (30). Secure with eight capscrews (33).
- b. Torque capscrews (33) to 50-75 lb . ft.
- c. Torque nut (31) to 300-400 lb.
- 6. IF REMOVAL WAS NECESSARY, INSTALL RING GEAR (18).

## **CAUTION**

Ring gear (18) must be heated before installation. Failure to heat ring gear (18) before installation could cause damage to differential case half (22) because of a tight fit.

 Expand ring gear (18) by heating in a tank of water to a temperature of 1600F to 1800F for 10 to 15 minutes.





#### **WARNING**

Wear gloves and proper clothing while handling hot ring gear (18). Failure to follow this precaution could result in serious personal injury.

- b. Use a sling and hoist to lift the ring gear (18) from tank of water.
- c. Install ring gear (18) on flange case half (22) immediately after heating. If ring gear (18) does not fit easily on flange case half (22), repeat STEP a.
- d. Align fastener holes of ring gear (18) and flange case half (22) by rotating ring gear (18) as needed.
- e. Properly install twelve new rivets (28) in pairs opposite each other (B and C) from the flange case half (22) side of the assembly (side opposite gear teeth) as shown. Rivet head must be against flange case half (22).

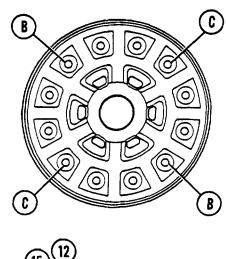
## **CAUTION**

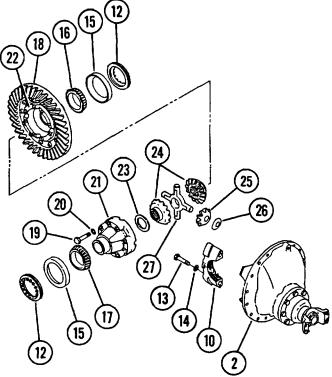
Do not heat rivets (28) before installation. Use only cold rivets for proper fastening.

## **CAUTION**

Pressure on rivets (28) must be held for approximately one minute so that rivet body will completely fill hole. Failure to do so could cause rivet failure.

f. Use a riveting machine to press rivets (28) into place from ring gear (18) side of the assembly. Press rivets (28) in pairs opposite each other. Apply 60,000 lb. of pressure.





- g. Use a 0.003 inch feeler gauge to check for gaps between back surface of ring gear (18) and flange case half (22). If gauge fits more than half way to rivets, remove ring gear (18); see DISASSEMBLY STEP 3, a through d and repeat STEP 6, a through f. If gap persists, inspect flange case half (22) and ring gear (18) for problem, replace defective parts.
- h. Use a press and suitable sleeve driver to install bearing cone (16) on flange case half (22).
- Use a press and suitable sleeve to install bearing cone (17) on plain case half (21).
- Apply gear lubricant to inside surfaces of both case halves (21 and 22), two thrust washers (23), two side gears (24), and four pinion gears (25).
- I. Place flange case half (22) on bench, ring gear (18) teeth up.
- m. Install one thrust washer (23) and side gear (24) into the flange case half (22).
- Install four pinion gears (25) and four pinion gear thrust washers (26) on differential spider (27). Install differential spider assembly into flange case half (22).
- Install second side gear (24) and thrust washer (23) over spider (27) and differential pinion gears (25).
- Place plain case half (21) over flange case half (22) and gears (24 and 25). Rotate plain case half (21) as needed to align match marks.

# **CAUTION**

Spacing between first four installed capscrews (19) must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

- q. Apply Loctite #277 to eight capscrews (19). Install four of the eight capscrews (19) and four flatwashers (20), as opposing pairs (D and E), into case halves (21 and 22).
- r. Torque four capscrews (19) to 60-75 lb . ft.

#### NOTE

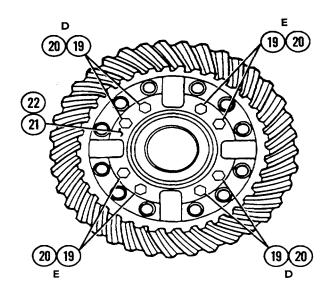
Torque capscrews (19) in pairs opposite each other.

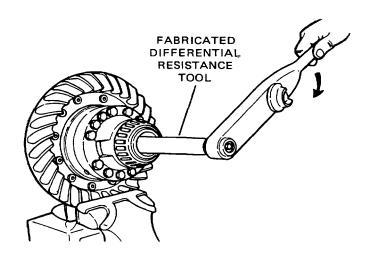
- s. Install remaining four capscrews (19) and four flatwashers (20). Torque to 60-75 lb. ft.
- 7. CHECK ROTATING RESISTANCE OF DIFFERENTIAL GEARS.

#### NOTE

Fabricate a tool from an axle's shaft that matches the spline of differential side gear (24).

- Put differential in a soft-jaw vise in the normal operating position.
- Install fabricated differential resistance tool (App . C , Fig . C-3) into spline of one side gear.
- Put torque wrench on end of differential resistance tool.
   Read the value of torque wrench as differential gears are rotated.



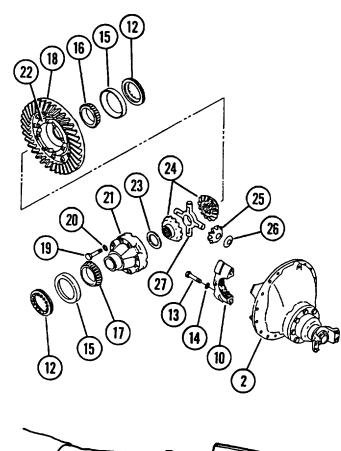


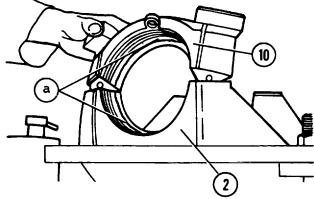
- d. If torque value exceeds 50 lb. ft., disassemble differential. Inspect case halves (21 and 22), spider (27), gears (24 and 25), and washers (23 and 26) for cause of high torque reading. Replace parts as necessary.
- 8. INSTALL DIFFERENTIAL AND RING GEAR ASSEMBLY.
  - a. Clean and dry bearing cups (15),bores of differential carrier(2) legs and bearing caps (10).
  - Apply thin film of gear oil to inner diameter of the bearing cups (15) and on both bearing cones (16 and 17).

#### **NOTE**

When installing bearing cups (15) into bearing bores of differential carrier (2) apply Loctite #277 to bearing bores (a) of differential carrier (2) and bearing caps (10). Do not allow Loctite #277 to get into adjusting ring (12) threads.

- Apply thin bead of Loctite #277
  to bearing bores of differential
  carrier (2) legs and bearing
  caps (10). Do not apply Loctite
  #277 to adjusting ring (12)
  threads.
- d. Install two bearing cups (15) over bearing cones (16 and 17) on case halves (21 and 22).





e. Use a sling and hoist to carefully lift differential and ring gear (15-27) as an assembly and install into differential carrier (2). Bearing cups (15) must be flat against bores between differential carrier (2) legs.

## **CAUTION**

Install bearing caps (10) in correct location to avoid thread damage by cross-threading adjusting rings (12), when installed, or mismatching bearing caps (10).

- f. Install bearing caps (10) over the assembled bearing cups and bearing cones (16 and 17). Use match marks made during disassembly to match original location of bearing caps.
- g. Install capscrews (13) and flatwashers (14) and tighten hand tight.

## **CAUTION**

Install adjusting rings (12), using care not to cross-thread the rings or the caps. A plastic or leather mallet can be used to align the rings and caps during installation. DO NOT force adjusting rings; damage to threads may result.

- h. Install adjusting rings (12) and tighten hand tight against each bearing cup (15).
- i. Torque capscrews (13) to 110-145 lb . ft.

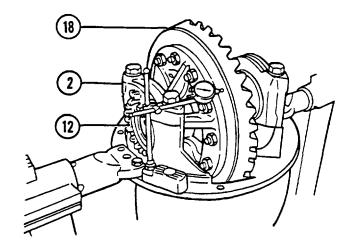
# **ADJUSTMENT**

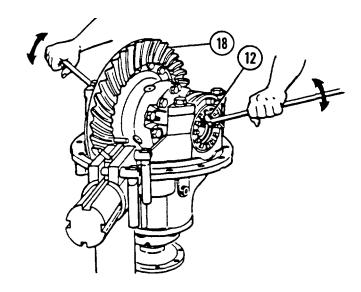
- 1. ADJUST PRELOAD OF DIFFERENTIAL BEARINGS (15-17).
  - a. Attach a dial indicator on the mounting flange of the differential carrier (2).
  - Adjust the dial indicator so that the plunger is against the back surface of the ring gear (18).
     Adjust dial indicator to zero.

#### **CAUTION**

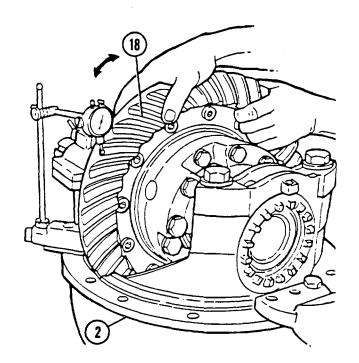
When turning bearing adjusting rings (12), always use a tool that engages two or more opposite notches in the ring. A large screwdriver can be used for this purpose. Failure to engage at least two notches could cause damage to adjusting ring lugs.

- c. Loosen the bearing adjusting ring (12) opposite ring gear (18) so that a small amount of end play shows on dial indicator. Move differential assembly with ring gear (18) left and right with suitable pry bars while reading dial indicator. DO NOT allow pry bars to touch bearings (15-17).
- d. Tighten bearing adjusting ring (12) opposite ring gear (18) so that no end play shows on dial indicator. Move the differential assembly and ring gear (18) left and right as needed to be sure no end play is present.
- e. Tighten each bearing adjusting ring (12) one notch from the zero end play measured in STEP d.





- 2. CHECK RUNOUT OF RING GEAR (18).
- a. Attach dial indicator on mounting flange of differential carrier
   (2) . Adjust dial indicator so that plunger is against back surface of ring gear (18).
- b. Adjust dial of indicator to zero.
- c. Rotate differential assembly and ring gear (18) and read dial indicator. If runout of ring gear (18) exceeds 0.008 inch, remove differential assembly and ring gear (18), DISASSEMBLY STEP 1, and inspect differential assembly for problem. Replace defective parts and install differential assembly and ring gear (18) into differential carrier (2), ASSEMBLY STEP 7. Repeat preload adjustment of differential bearings, STEP 1.
- 3. ADJUST BACKLASH OF RING GEAR (18).
  - a. Attach a dial indicator to the mounting flange on differential carrier (2).
  - b. Adjust dial indicator so that plunger is against the tooth surface on ring gear (18).
  - c. Adjust dial of indicator to zero.
  - d. Hold bevel pinion in position so it does not move.
  - e. Read dial indicator while rotating ring gear (18) in both directions against teeth of bevel pinion.



- If old gear set is installed, backlash must be 0.008-0.018 inch or setting before carrier was disassembled.
- (2) If new gear set is installed, backlash must be 0.012 inch.
- (3) Adjust backlash as necessary by following STEPS f and g.

#### NOTE

When adjusting backlash, only the ring gear (18) and differential are adjusted; do not adjust the bevel pinion (29).

- f. Increase backlash by loosening bearing adjusting ring (12) on gear (18) side, and tightening bearing adjusting ring (12) away from ring gear (18) side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.
- g. Decrease backlash by tightening bearing adjusting ring (12) on ring gear (18) side, and loosening bearing adjusting ring (12) away from ring gear (18) side of differential assembly.

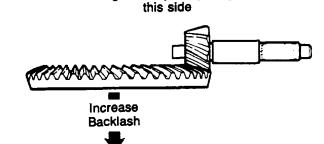
  Make adjustments one notch at a time until backlash is within specifications.
- 4. CHECK TOOTH CONTACT PATTERNS OF THE GEAR SET.

# **NOTE**

In the following steps, movement of contact pattern in length of tooth is indicated as toward "toe" (F) or "heel" (G) of ring gear.

#### NOTE

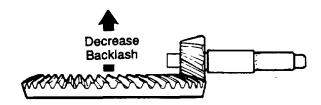
Always check tooth contact patterns on drive side of gear teeth.



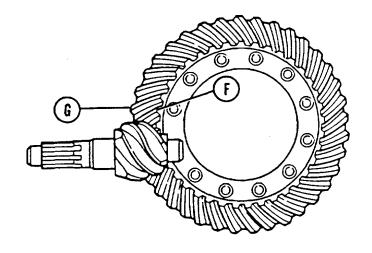
Tighten Adjusting Ring

Loosen Adjusting Ring this side

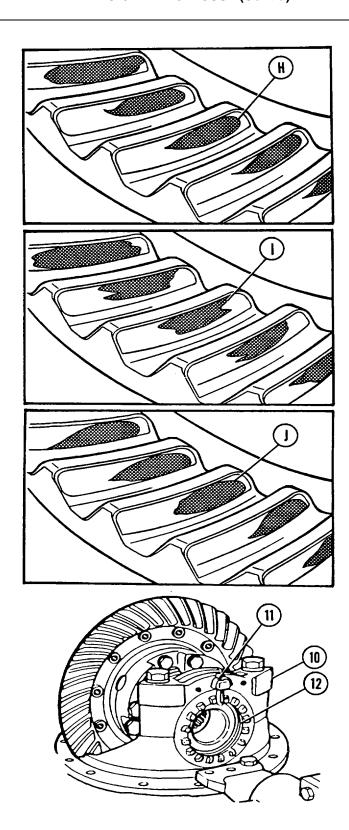
Loosen Adjusting Ring this side



Tighten Adjusting Ring this side



- Apply marking compound to 12 gear teeth of ring gear.
   Rotate ring gear so that 12 gear teeth are next to bevel pinion.
- Rotate ring gear (18) forward and backward so that 12 marked teeth go past bevel pinion six times to get contact patterns. Repeat, if necessary, to get a clearer pattern.
- c. Inspect contact patterns on ring gear (18). Good hand rolled pattern (H) will show contact toward toe of gear tooth and in the center between top and bottom of tooth. A high pattern (I) will show contact closer to top of gear tooth. A low pattern (J) will show contact toward bottom of gear tooth. When in operation, pattern will extend to approximately full length of gear tooth.
- d. If necessary, install thinner shim pack (34) under pinion bearing cage (30) to correct high contact pattern.
- e. If necessary, install thicker shim pack (34) under pinion bearing cage (30) to correct low contact pattern.
- f. If necessary, decrease backlash, STEP 3, g. to move contact patterns toward toe of ring gear teeth.
- g. If necessary, increase backlash, STEP 3, f. to move contact patterns toward heel of ring gear teeth.
- h. Install two new cotter pins (11) that hold two bearing adjusting rings (12) in position . Install cotter pins (11) through boss of bearing cap (10) and between lugs of adjusting ring (12).



## **INSTALLATION**

#### **NOTE**

When installing differential carrier (2), apply silicone RTV sealant to the mounting surface of the axle housing (8).

1. INSTALL DIFFERENTIAL CARRIER (2) INTO AXLE HOUSING (3).

#### **NOTE**

Inside of axle housing and mounting flange where carrier fastens should be clean and dry before installing carrier.

# WARNING

Minor concentrations of acetic acid may be produced during application of silicone RTV-732 sealing compound.

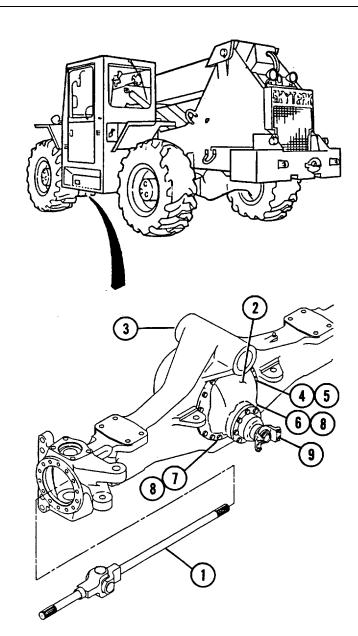
Adequate ventilation should be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

 a. Apply a 1/8 inch bead of silicone RTV-732 clear sealing compound to differential mounting surface of axle housing (3). Be sure to apply sealing compound around each tapped hole of mounting surface.

## **CAUTION**

Be sure bearing caps of differential fit inside lugs inside of axle housing. Do not force differential into housing or damage will occur to housing and differential.

b. Install differential carrier (2) into axle housing (3).



## **CAUTION**

First four installed capscrews (4) must be evenly spaced to prevent uneven pressure on differential carrier (2) when torquing . Failure to do so could cause component damage.

- c. Install four capscrews (4) and flatwashers (5) into corner locations around differential carrier (2) and axle housing (3). Hand tighten.
- d. Carefully push differential carrier (2) into position.

  Tighten four capscrews (4) two or three turns each in a pattern opposite each other.

#### NOTE

Torque capscrews (4) in pairs on opposing sides of differential carrier (2).

e. Torque capscrews (4) to 50-75 lb. ft . Torque in pairs across from each other.

- f. Install remaining eight capscrews
  (4), two capscrews (6), two capscrews (7), four flatwashers
  (8) and eight flatwashers (5).
  Be sure fasteners are in correct location as noted during disassembly.
- g. Carefully install axle shafts (1) into axle housing (3) so not to damage bushings or seals in axle housing.
- h. Carefully move axle housing (3) to upright position.
- 2. INSTALL REAR PLANETARY WHEEL ENDS , PARA . 9-6.
- 3. FILL AXLE HOUSING WITH LUBRICANT, TM-10-3930-660-20.
- 4. INSTALL REAR AXLE ASSEMBLY ON VEHICLE, PARA. 9-3.

# 9-6. REAR PLANETARY WHEEL ENDS --- REPLACE

#### This task covers:

a. Removalb. Cleaning

c. Inspection

d. Installation

## **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment , Automotive Maintenance , Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Snap Ring (5, 9) Maintenance, Basic, Less Power

Lifting Device (Capacity 2000 lb.)

Fabricated Tool-Hub Drag Tool (App. C, Fig. C-4)

4 inch by 4-1/2 inch deep six-point socket

## **Equipment Condition**

Rear of vehicle raised 8 inches and supported under rear axle. Planetary wheel end drained, LO10-3930-660-12. para.

#### Materials/Parts

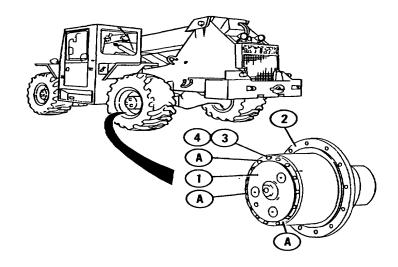
Gear Lubricating Oil (App. B, Item 32)
Lint-Free Rags (App. B, Item 38)
Oil Pan
RTV-732 Clear Sealing Compound
(App. B, Item 7)

Wheel assembly removed , TM10-3930-660-20. Rear disc brake assembly removed , 10-3.

#### **REMOVAL**

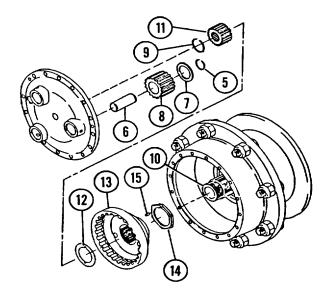
## 1. REMOVE PLANETARY GEAR ASSEMBLY.

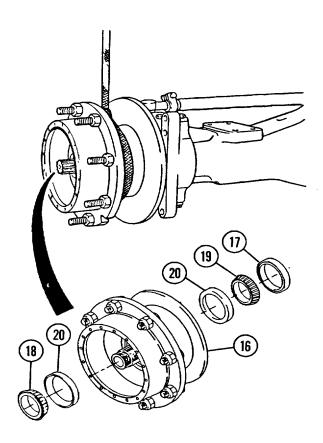
- a. Mark planetary spider (1) and wheel hub (2) for correct alignment during installation.
- b. Place a suitable container under planetary wheel end assembly.
- c. Remove sixteen capscrews (3) and sixteen flatwashers (4) from planetary spider (1).
- d. Place three capscrews (3) in jack screw holes (A) and tighten to remove planetary spider (1).



## 9-6. REAR PLANETARY WHEEL ENDS - REPLACE (Cont'd)

- 2. DISASSEMBLE PLANETARY SPIDER ASSEMBLY (6-8).
  - a. Remove and discard three snap rings (5) from planetary pinion shafts (6).
  - b. Remove three thrust washers (7) and planetary gears (8) from planetary pinion shafts (6).
- 3. REMOVE PLANETARY SUN GEAR (11) AND RING GEAR (13).
  - Remove and discard snap ring (9) from end of axle shaft.
  - b. Remove planetary sun gear (11).
  - c. Remove sun gear thrust washer (12).
  - d. Remove planetary ring gear (13).
- 4. REMOVE WHEEL HUB AND DISC ASSEMBLY (16).
  - Use a sling and hoist or other suitable lifting device to support hub weight during removal.
  - b. Remove hub bearing nut (14) . If necessary , remove dowel pin (15).
  - c. Wobble wheel hub and disc assembly (16) to unseat inner (19) and outer (18) bearing cones.
  - d. Remove outer bearing cone (18).
  - e. Remove wheel hub and disc assembly (16).
  - f. Remove inner oil seal (17).
  - g. Remove inner bearing cone (19).
  - h. If necessary, remove two bearing cups (20) with a suitable puller.





## 9-6. REAR PLANETARY WHEEL ENDS - REPLACE (Cont'd]

#### REMOVE SPINDLE ASSEMBLY.

a. Remove ten spindle capscrews(21), four shorter capscrews(22), and fourteen flatwashers(23).

#### **CAUTION**

Inner oil seal (25) and bushing (24) in bore of spindle can be damaged when sliding spindle past axle splines. Remove spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure.

- b. Remove wheel bearing spindle (10).
- c. Remove oil seal (25).
- d. If necessary, remove bushing (24).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

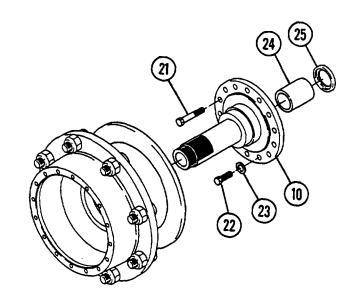
See Inspection Instructions, para. 2-11.

## **INSTALLATION**

- 1. ASSEMBLE SPINDLE (10).
  - a. If removed, push bushing (24) into spindle (10) until top of bushing is flush or just below bottom of bore for seal (25).
  - b. Push seal (25) to bottom of bore.

## 2. INSTALL SPINDLE ASSEMBLY.

 Apply a thin film of gear lubricating oil to lips of oil seal (25) in spindle (10) bore, bore of bronze bushing (24) in spindle and oil seal journal on axle shaft short end.



# 9-6. REAR PUANTARY WHEEL ENDS - REPLACE (Cont'd)

## **CAUTION**

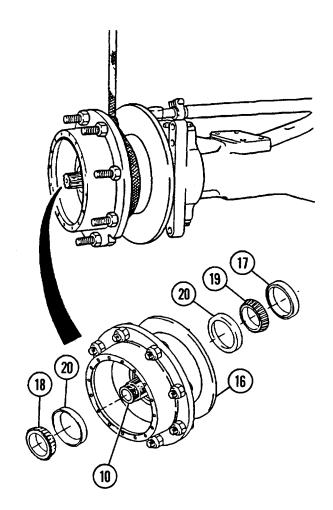
Inner oil seal (25) and bushing (24) in bore of spindle (10) could be damaged when sliding spindle past axle splines. Install spindle carefully to avoid damaging bushing inner oil seal (25). Failure to do so could cause premature component failure.

b. Install spindle (10).

#### **NOTE**

Install two shorter capscrews (22) at two top holes and two capscrews (22) at bottom two holes.

- c. Install ten capscrews (21), four shorter capscrews (22), and fourteen flatwashers (23) to secure wheel bearing spindle (10). Torque capscrews (21 and 22) to 150 lb. ft.
- 2. INSTALL WHEEL HUB AND DISC ASSEMBLY (16).
  - a. Install two bearing cups (20) with a suitable driving sleeve into wheel hub (10).
  - b. Place wheel hub and disc assembly (16) on floor or bench with the brake disc up.
  - Apply a thin film of gear lubricating oil to inner bearing (19) and install in inner bearing cup (20).
  - d. Install oil seal (17) with a suitable driver.
  - e. Use a sling and hoist or other suitable lifting device to support weight of wheel hub and disc assembly (16).



## 9-6. REAR PLANETARY WHEEL ENDS - REPLACE (Cont'd)

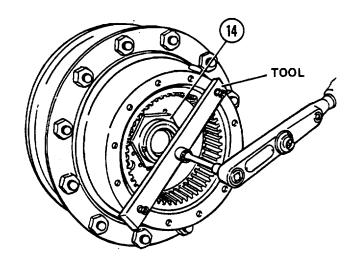
- f. Apply a thin film of gear lubricating oil to inside diameter of oil seal (17) and to oil seal journal surface of wheel bearing spindle (10).
- g. Align wheel hub and disc assembly (16) with wheel bearing spindle (10). Push wheel hub and disc assembly (16) onto spindle (10).
- h. Install outer bearing cone (18) in outer bearing cup (20).
- i. Install hub bearing nut (14) and draw wheel hub and disc assembly (16) into position while rotating wheel hub.

#### PRELOAD WHEEL BEARINGS.

- a. Seat bearings and related components by tightening the hub bearing nut (14) to 100 lb. ft . while hub is rotated in both directions.
- Back off hub bearing nut (14) to relieve preload on bearings.
   Torque on nut should be 0 lb. ft.
- Use fabricated hub drag tool and a torque wrench to check rolling torque while hub is rotating at a steady rate (not starting torque).
   Record torque.
- d. Tighten hub bearing nut (14) and check hub rolling torque again.
   Increase in rolling torque from zero preload, should be 36 to 60 lb. in. for new bearings.

#### **NOTE**

If bearings are to be reused, the increase in rolling torque should be 1.5 to 2.5 lb. ft.



# 9-6 REAR PLANETARY WHEEL ENDS - REPLACE (Cont'd)

- 4 INSTALL PLANETARY RING GEAR (13) AND SUN GEAR (11).
  - a Install dowel pin (15), if removed.
  - b Locate hole (A) on back of planetary ring gear (13) Orient ring gear (13) with respect to dowel pin (15) on wheel hub bearing nut (14).

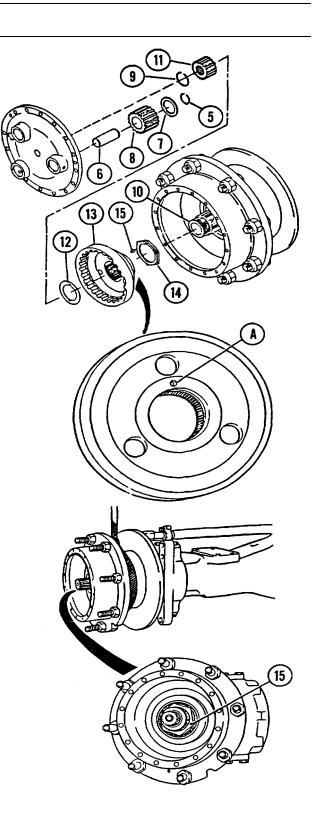
#### **NOTE**

If pin (15) is not aligned with hole (A) of ring gear, spider assembly (1) will not fit tight to wheel hub.

- c. Install planetary ring gear (13)
  It may be necessary to turn hub
  bearing nut (14) to match hole
  (A) on back of planetary ring
  gear (13) Hub bearing nut (14)
  may be tightened to match dowel
  pin (15) with planetary ring
  gear, but torque on hub bearing
  nut (14) should not exceed 150
  lb ft.
- d. Install sun gear thrust washer (12), sun gear (11) and spindle snap ring (9) Tangs on thrust washer (12) must engage slots in ring gear (13).

# **5 ASSEMBLE PLANETARY SPIDER**

- a. Apply a thin film of gear lubricating oil to bore of planetary gear (8) Slide planetary gear (8) and outer thrust washer (7) onto planetary pinion shaft (6).
- b. Install snap ring (5) onto planetary pinion shaft (6).
- c. Repeat STEPS a and b for second and third sets of planetary gears (8), thrust washers (7), and snap rings (5).



#### 9-6 REAR PLANETARY WHEL ENDS - REPLACE (Cont'd)

#### 6. INSTALL PLANETARY GEAR ASSEMBLIES

- Remove dirt, grease or moisture from the mating surfaces of the spider flange and hub mounting face
- b. Dry both surfaces

#### WARNING

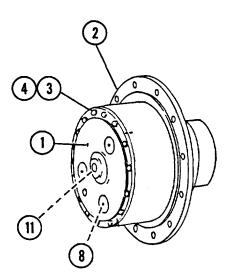
Adequate ventilation should be provided when silicone RTV-732 clear sealing compound is applied in confined areas Failure to do so could cause respiratory irritation, headaches and nausea Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor

c. Apply a continuous bead of silicone RTV-732 clear sealing compound approximately 1/8 inch in diameter completely around the hub mounting face and around the inner edge of all fastener holes to assure complete sealing and prevent leakage

#### NOTE

Assemble components immediately to permit silicone RTV-732 clear sealing compound to spread evenly Failure to do so could cause axle to leak

- d Start planetary spider (1) onto wheel hub (2), aligning teeth of planetary gears (8) with sun gear (11) and ring gear (13) teeth
- e Align the match marks on the spider flange and wheel hub as previously marked during removal



- f. Align holes on wheel hub (2) with holes on planetary spider (1) flange and push spider assembly against hub (2)
- g. Install sixteen capscrews (3) and flatwashers (4)
- h. Tighten capscrews (3) and torque to 60-75 lb ft
- 7. FILL PLANETARY WHEEL ENDS WITH LUBRICANT, L010-3930-660-12
- 8. INSTALL REAR DISC BRAKE ASSEMBLY, PARA 10-3
- 9. INSTALL WHEEL ASSEMBLY, TM10-3930-660-20

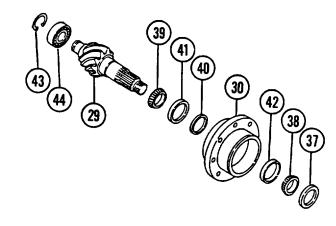
- d. Use an expanding snap ring pliers to install snap ring (43) into groove on end of bevel pinion (29)
- e. Apply a thin film of gear lubricant to inner and outer bearing cups (41 and 42) and bearing cones (38 and 39)
- f. Install bearing spacer (40) on bevel pinion against inner bearing cone (39)
- g. Install bevel pinion (29) and bearing assembly into bearing cage
- h. Use a press and suitable sleeve driver to install outer bearing cone (38) on bevel pinion tight against bearing spacer (40)
- i. Install pinion bearing thrust washer (37)
- 2. ADJUST PRELOAD OF BEARINGS (38, 39, 41 AND 42) ON BEVEL PINION (29)
  - a Install companion yoke (9), nut (31) and washer (32) on bevel pinion (29) If necessary, use a press to push yoke on pinion Companion yoke (9) must be against thrust washer (37)

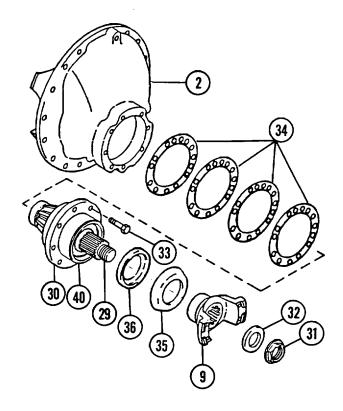
NOTE

Shims (34) are not installed at this time

b. Temporarily install bevel pinion

 (29) and bearing cage (30)
 assembly in differential carrier
 (2) <u>Do not install shims</u> (34)
 under bearing cage (30)



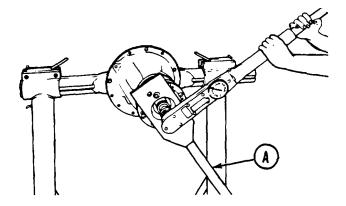


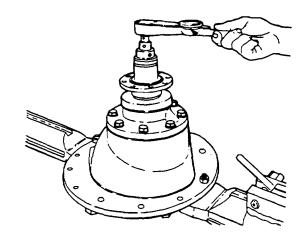
- c. Install eight capscrews (33) finger tight
- d. Fasten a fabricated yoke nut tool
  (App B, Fig, C-5) to companion yoke
  (9) Use a fabricated yoke nut tool
  (A) to hold bevel pinion (29) in
  position when nut (31) is tightened
- e. Torque nut (31) on bevel pinion (29) to 300 400 lb ft
- f. remove bar from companion yoke (9)

#### NOTE

Do not read starting torque Read only torque value after bevel pinion (29) starts to rotate Starting torque will give a false reading

- g. Attach a lb in torque wrench on bevel pinion nut (31) Rotate bevel pinion (29) and read value indicated on torque wrench New pinion bearings should be preloaded between 5 and 45 lb in of torque Reused pinion bearings should be preloaded between 10 and 30 lb in
  - Increase bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thinner bearing spacer (40) Repeat STEPS a through g.
  - 2). Decrease bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thicker bearing spacer (40) Repeat STEPS a through g.





#### **CHAPTER 10**

#### **BRAKE SYSTEM MAINTENANCE**

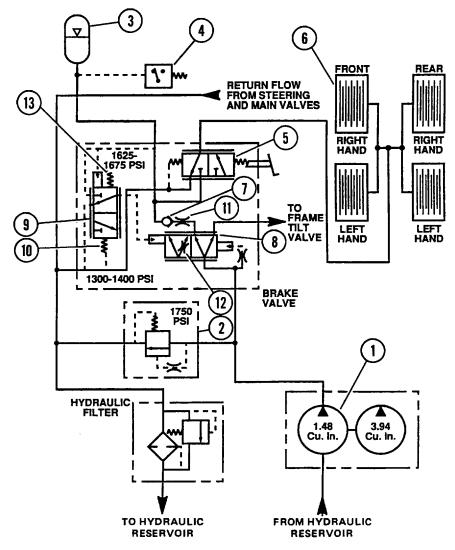
#### Section I DESCRIPTION AND DATA

#### 10-1 GENERAL

This chapter covers maintenance procedures for the service brake system components, as well as principles of operation.

## **10-2 PRINCIPLES OF OPERATION**

a. <u>General</u> Hydraulic fluid to operate the service brakes is drawn from the main hydraulic reservoir by the small (1 48 cu in ) section (1) of the dual gear pump. The frame tilt circuit is supplied by the same pump section. Protection for the circuit is provided by relief valve (2), which is designed to bypass when circuit pressure reaches 1750 psi.



Pressure to operate the brakes is supplied by accumulator (3) Pump (1) flow is used in the brake circuit solely to maintain the accumulator charge. Pressure switch (4) is used to monitor brake circuit operating pressure and turns on the LOW BRAKE PRESS warning light in the cab if pressure drops to below approximately 650 psi.

b. Accumulator Charging Cycle Force to operate the service brakes is produced by and the frame tilt valve (not shown) back to the reservoir the precharge pressure in the accumulator (3) When the brake foot pedal is depressed, a path is completed from accumulator (3). through ball valve (5) to wheel brakes (6). Pressure exerted by the accumulator is applied equally to the cylinders of all four wheel brakes (6). The path between accumulator (5) and pump (1) is blocked at this time by check valve (7), which is seated by accumulator pressure. Check valve (7) will remain seated as long as accumulator pressure is higher than pump pressure Charging valve (8) will then be in the position shown, and all flow from pump (1) will pass through charging valve (8) and the frame tilt valve (not shown) back to the reservoir.

When, during brake operation, accumulator pressure drops below a preset pressure established by design of pilot valve (9), charging valve (8) must be shifted to permit recharging of the accumulator. When accumulator pressure reaches its lower limit, pilot spring (10) will force the spool in pilot valve (9) upward (as shown) Accumulator pressure is then applied through ports in pilot valve (9) to the left end of the spool in charging valve (8), shifting the spool to the right (as shown). Since pump pressure is higher than accumulator pressure at this time, check valve (7) will be unseated and pump flow is permitted through the charging valve ports and check valve (7) to the bottom of accumulator (3). Orifice (11) in the check valve seat restricts the rate of flow to accumulator (3) Orifice (12) in charging valve (8) limits flow to frame tilt circuit while charging valve (8) is shifted to allow accumulator recharging.

When accumulator pressure again reaches its upper limit, accumulator pressure combined with force of spring (13) will overcome the force of pilot spring (10) and shift pilot valve (9) spool downward (as shown). This will remove accumulator pressure from the left end of charging valve (8) spool and permit pump pressure to again shift charging valve spool to the left (as shown). Check valve (7) will again be seated by higher accumulator pressure and block the path between pump (1) and accumulator (3)

#### Section II BRAKE SYSTEM MAINTENANCE PROCEDURES

#### BRAKE MAINTENANCE TASK SUMMARY

TASK PARA	PROCEDURES	PAGE NO
10-3	Disc Brake Assembly - Replace/Repair	10-3
10-4	Brake Control Valve - Repair	10-9

## 10-3 DISC BRAKE ASSEMBLY - REPLACE/REPAIR

This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

## Initial Setup

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power

Cap and Plug Set Equipment Condition

Service brake shoes removed,

TM10-3930-660-20

Materials/Parts

Back-Up Ring (14)
Emery Cloth (App B, Item 5)
Hydraulic Oil (App B, Item 35)
Lint-Free Rags (App B, Item 38)
Loctite 271 (App B, Item 43)
Loctite 59241 (App B, Item 45)
O-ring (11, 13)
Tags (App B, Item 52)
Wood Block

## **REMOVAL**

## **WARNING**

Always use blocks, jackstands, or other rigid, stable supports when working beneath raised equipment. Ensure that hoists or jacks are in good condition. Never use frayed, twisted, or pinched cables Never use bent or distorted hooks. Failure to follow this precaution could result in severe personal injury or machine damage

## **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines.

Contamination of the hydraulic system could result in premature failure.

- 1 DISCONNECT LINE (1) FROM BRAKE HOUSING
- 2 REMOVE FOUR CAPSCREWS (2) AND FOUR WASHERS (3)
- 3 REMOVE DISC BRAKE (4)
- 4 REPEAT STEPS 1-3 FOR OTHER DISC BRAKES

# **DISASSEMBLY**

- 1 REMOVE TWO PISTONS (7) FROM HOUSING (6) SIDE OPPOSITE THE MOUNTING PLATE
  - a Use a C-clamp to hold a 1/2 inch wood block against the two pistons(5) on mounting side of housing(6).

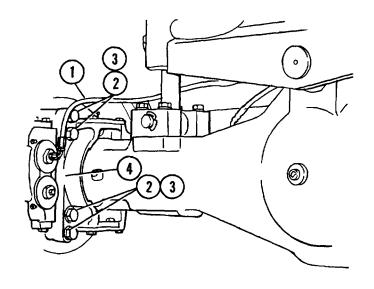
# **WARNING**

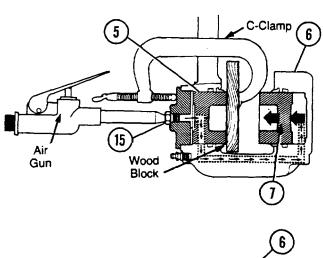
Do not put hands in front of the pistons when forcing out the pistons. Failure to follow this precaution could result in severe personal injury.

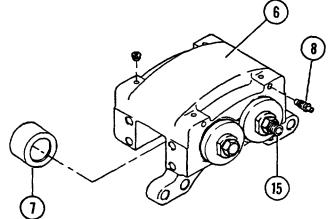
# **WARNING**

DO NOT exceed 30 psig nozzle pressure when drying parts with compressed air. Always wear safety glasses Do not direct compressed air against human skin. Failure to follow these instructions may result in SERIOUS INJURY or DEATH.

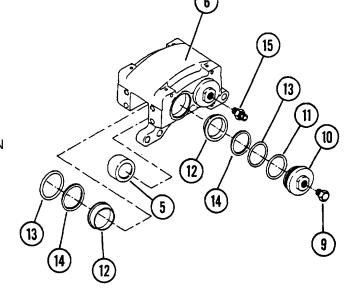
- b Use compressed air at inlet fitting (15) to force pistons (7) out of housing (6). Place a piece of wood in front of the piston (7) that comes out first so other piston will be forced out
- c Remove two pistons (7) from housing (6) bores opposite from mounting plate







- 2 REMOVE TWO BLEEDER SCREWS (8) FROM HOUSING. (6)
- 3 REMOVE TWO CYLINDER HEADS (10)
  - a Remove plug (9) and fitting (15) from two cylinder heads (10).
  - b Use an open-end wrench on the two flat areas on top of cylinder head (10) Remove two cylinder heads
    - (10) from housing (6).
  - c Remove and discard O-ring (11) from each cylinder head (10).
- 4 USE A WOOD BLOCK OR DOWEL AND PUSH ON TWO PISTONS (5) TO FORCE PISTONS OUT FROM THE MOUNTING SIDE OF HOUSING (6) TOWARDS DISC SIDE
- 5 REMOVE FOUR DUST SEALS (12) FROM HOUSING (6)
- 6 REMOVE FOUR O-RINGS (13) AND FOUR BACKUP RINGS (14) DISCARD O-RINGS (13) AND BACKUP RINGS (14)



#### **CLEANING**

See Cleaning Instructions, para 2-10

# **INSPECTION**

- 1 INSPECT PISTONS (5 AND 7)
  - a. Inspect pistons (5 and 7) for scratches and rust Use emery cloth to remove small scratches and rust Discard parts if there are large scratches or amounts of rust
  - b. Measure outer diameter of pistons (5 and 7) Discard pistons if the outer diameter is less than 2 995 inch

# 2 INSPECT HOUSING (6)

- a Inspect piston bores and ring grooves in housing for scratches and rust Use emery cloth to remove small scratches and rust Discard housing if there are large scratches or amounts of rust
- b Measure inner diameter of piston bores in housing (6) Discard housing if inner diameter of bore s more than 3 003 inch

#### **ASSEMBLY**

# **WARNING**

Use only specified parts when assembling the disc brake Do not mix parts from other disc brakes If installing the wrong parts, the disc brake will not operate correctly and could result in severe personal injury and equipment damage

# **NOTE**

Wipe all sealing surfaces on disc brake clean and dry Apply film of clean hydraulic oil to all seals, pistons, and bores as parts are installed

# 1 INSTALL SEALS IN HOUSING (2)

a Install new backup ring (14) and new O-ring (13) in middle groove of each bore The backup ring (14) is installed toward the lining side of housing (6) The O-ring (13) is installed towards the outside of the housing b Install four dust seals (12) in inner groove of housing bore

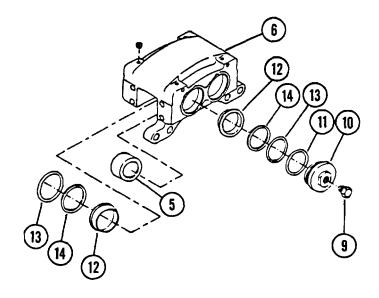
- 2 INSTALL PISTONS (5 AND 7) IN HOUSING (6)
  - a. Install pistons (5 and 7) in from lining side of housing (6).
  - Ensure that pistons (5 and 7) are straight in housing (6) bores.
     Push each piston (5 and 7) into housing bore until top of piston is even with top of dust seal (12).
- 3 INSTALL TWO CYLINDER HEADS (10)
  - a. Install a new O-ring (11) on two cylinder heads (10). Ensure that O-rings (11) are not cut by threads on cylinder head (10).
  - b. Install two cylinder heads (10) in housing (6) Torque cylinder heads (10) to 75 lb ft.
  - c. Apply Loctite 59241 pipe sealant to threads of plug (9) and fitting (15). Install plug (9) and fitting (15) in two cylinder heads (10)
- 4 INSTALL TWO BLEEDER SCREWS (8) IN HOUSING (6)

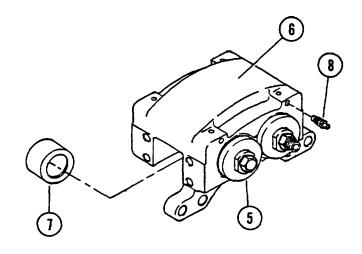
# **INSTALLATION**

# NOTE

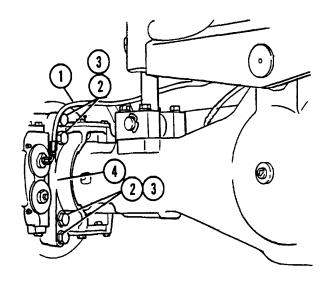
Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on disc brake clean and dry.

- 1 POSITION DISC BRAKE (4) ON DISC
  - a. Check proper location of disc brake in relation with the disc.
  - b. Verify that disc is centered between disc brake housing.





- 2. APPLY LOCTITE 271 ON CAPSCREW (2) THREADS INSTALL FOUR WASHERS (3) AND FOUR CAPSCREWS (2) TORQUE CAPSCREWS (2) TO 280 LB FT.
- 3. INSTALL DISC BRAKE LINING, TM10-3930-660-20.
- 4. CHECK TO SEE THAT LININGS ARE FREE TO MOVE .
- 5 CONNECT LINE (1) TO BRAKE HOUSING.
- 6 INSTALL WHEEL ASSEMBLY, TM10-3930-660-20.
- 7 BLEED AIR FROM BRAKES, TM10-3930-660-20.



# 10-4 BRAKE CONTROL VALVE - REPAIR

This task covers:

a Disassembly

b Cleaning

c Inspection

d Assembly

# **Initial Setup**

**Tools** 

Tool Kit, Automotive Machanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

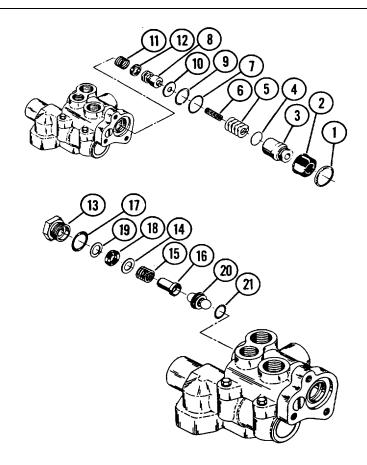
Equipment Condition
Brake control valve removed,
TM10-3930-660-20

Materials/Parts
Backup Ring (19)
Boot (2)
Cup (12, 18)
Filter (44)
Grease (App B, Item 11)
Hydraulic Oil (App B, Item 35)
Lint-Free Rags (App B, Item 38)
Lockwasher (56, 58)
O-ring (7, 17, 21, 23, 28, 34, 35, 38
42, 49, 52, 54, 61, 62)
Poppet (40)
Wooden Dowel

#### **DISASSEMBLY**

# 1 REMOVE INTERNAL PARTS (1-54) OF BRAKE CONTROL VALVE

- a Remove ring (1) and boot (2) Discard boot (2)
- b Remove piston (3), shim or shims (4) and springs (5 and 6)
- c Remove and discard O-ring (7)
- d Depress piston (8) and remove retaining ring (9)
- e Remove washer (10) and piston (8)
- f Remove spring (11) from piston (8)
- g Remove and discard cup (12) from piston (8)
- h Remove plug (13)
- i Remove washer (14), spring (15) and guide (16)

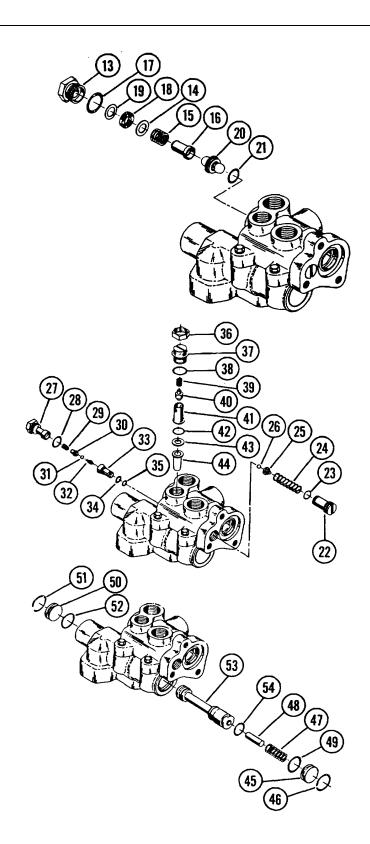


- j. Remove and discard O-ring (17), up (18) and backup ring (19).
- k. Remove valve and ball assembly (20).
- I. Remove and discard O-ring (21) from valve and ball assembly (20).
- m. Count and record number of turns required to remove plug and locking pin assembly (22) Remove and discard O-ring (23) from plug (22).
- n. Remove spring (24), seat (25) and ball (26)
- Remove plug (27) Remove and discard O-ring (28) from plug (27)
- p. Remove spring (29), stop (30), ball (31), spool (32) and insert (33).
- q. Remove and discard O-rings (34 and 35) from insert (33).
- r. Loosen nut (36) and remove adjusting screw (37).
- s. Remove and discard O-ring (38) from adjusting screw (37).
- t. Remove spring (39), poppet (40), seat (41), O-ring (42), washer (43) and filter (44) Discard poppet (40), O-ring (42) and filter (44).

# **WARNING**

Plug (45) is under tension of spring (47) Use care when removing retaining ring to prevent personal injury

u Depress plug (45) and remove retaining ring (46)

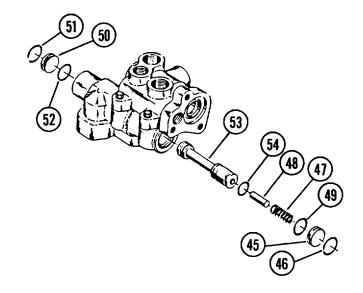


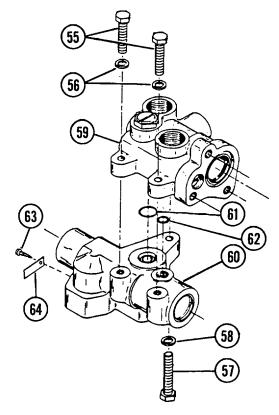
- v. Remove plug (45), spring (47) and stop (48).
- w. Remove and discard O-ring (49) from plug (45).
- x. Depress plug (50) and remove retaining ring (51).
- y. Remove plug (50) Remove and discard O-ring (52).

# **CAUTION**

Use extreme care when removing spool (53). Do not force spool (53) at any time during removal Failure to follow this precaution will result in part damage.

- z. Remove spool (53) The spool (53) can be guided out of valve by reaching into either large port on bottom Remove and discard O-ring (54) from spool (53)
- 2. SEPARATE AND DISASSEMBLE CONTROL HOUSING (59) FROM CHARGING SECTION (60)
  - a Remove two screws (55) and two lockwashers (56) Discard lockwashers (56)
  - b Remove screw (57) and lockwasher (58) Discard lockwasher (58)
  - c Separate control housing (59) from charging section (60)
  - d Remove and discard O-rings (61 and 62) from charging section (60)
  - e Remove two screws (63) and one label (64) if necessary





# **CLEANING**

See Cleaning Instructions, para 2-10

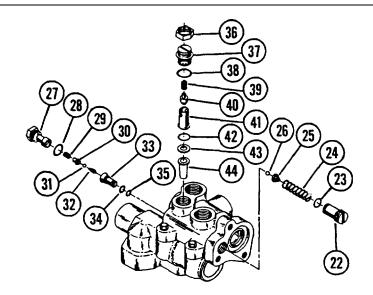
#### **INSPECTION**

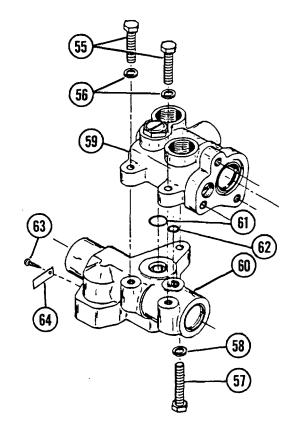
- 1 MEASURE SPOOL (32) AND BALLS (26 AND 31).
  - a Assemble spool (32) inside insert (33). Place balls (26 and 31) in respective seats. Measure across balls (26 and 31) with a micrometer Record measurement.
  - b. Remove spool (32) and place balls (26 and 31) on their respective seats. Measure with a micrometer.
  - c. Subtract smaller dimension from larger dimension If difference is less than 0 004 inch, replace spool (32) with a new one.
- 2 INSPECT PLUG AND LOCKING PIN ASSEMBLY (22).
  - a. The plug (22) has a nylon pin through threaded end so that plug will hold adjustment to which it is set. Screw plug into control housing (59).
  - b. Check to see if nylon pin has sufficient friction with threads to keep plug (22) from vibrating loose.
  - c. If there is no increase in torque required to turn plug (22) when pin engages threads, replace pin.

#### **ASSEMBLY**

# **NOTE**

Wipe all sealing surfaces on pump clean and dry Apply film of clean hydraulic oil to all seals as they are installed.



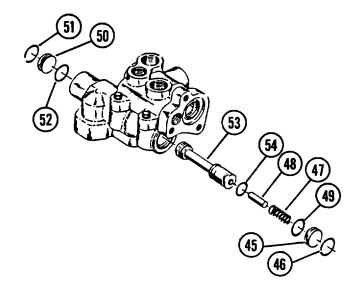


- 1 ASSEMBLE CONTROL HOUSING (59) TO CHARGING SECTION (60)
  - a. If removal was necessary, install one label (64) and two screws (63).
  - b. Install new O-rings (61 and 62) in charging section (60).
  - c. Assemble control housing (59) to charging section (60).
  - d. Install new lockwasher (58) and screw (57) Torque screw (57) between 22 and 27 lb ft.
  - e. Install two new lockwashers (56) and two screws (55) Torque screws (55) between 22 and 27 lb ft.
- 2 ASSEMBLE INTERNAL PARTS (1-54) OF VALVE .
  - a Install new O-ring (52) on plug (50). Install plug (52) with retaining ring (51).

# **CAUTION**

Use care to prevent damage to lands on spool (53) and inside bore. Do not force spool (53) into valve. Failure to follow this precaution will cause part damage

- Install new O-ring (54) on spool (53). Insert spool (53) into valve bore. Ensure that spool (53) is oriented correctly. Ensure that spool (53) makes contact with plug (50) on opposite side of valve.
- c. Install stop (48) and spring (47)
- d. Install new O-ring (49) on plug (45). Install plug (45) with retaining ring (46).

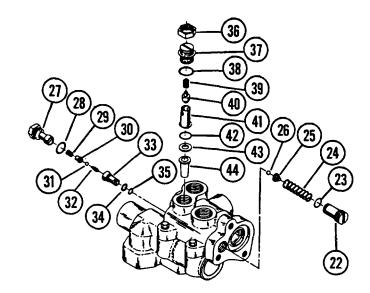


- e. Install new filter (44), washer (43), new O-ring (42), seat (41), new poppet (40) and spring (39).
- f. Install new O-ring (38) on adjusting screw (37) Install adjusting screws (37) and torque between 15-20 in lbs.
- g. Install nut (36) and torque between 15 and 20 lb ft.
- h. Install new O-rings (34 and 35) on insert (33) Use a wooden dowel to push insert (33) into valve.
- Install spool (32) into insert (33) Insert the short end of spool (32) first.
- j.Install ball (31) Ensure that ball (31) rests on insert (33).
- k. Apply grease on end of spring (29) to hold stop (30) in place Install stop (30) with spring 29).
- I. Install new O-ring (28) on plug (27) Install and torque plug (27) between 40 and 50 lb ft

# **CAUTION**

Ensure that ball (26) is on seat (25) before proceeding Failure to do so could cause part damage

m. Apply grease to hold ball (26) and seat (25) to spring (24). Install ball (26), seat (25) and spring (24).

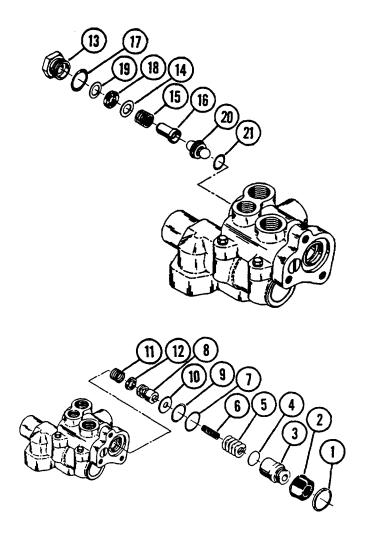


#### **NOTE**

The maximum accumulator pressure is adjusted by turning plug (22). The high pressure limit is increased by turning plug into valve. The low pressure limit is decreased by turning plug (22) out from valve.

- n. Install new O-ring (23) on plug (22) Install plug (22) and turn same number of times as recorded during disassembly.
- o. Install new O-ring (21) on valve and ball assembly (20). Insert valve and ball assembly (20) in valve.
- p. Install new cup (18) and backup ring (19) in plug (13).
- q. Install new O-ring (17) on plug (13) .
- r. Install guide (16), spring (15) and washer (14) in plug (13)
- s. Install plug assembly (13)

  Torque between 40 and 50 lb ft
- t. Install new cup (12) and spring (11) on piston (8) Install
- u. Install washer (10)
- v. Install retaining ring (9)
- w. Install new O-ring (7), springs (5 and 6), shim or shims (4) and piston (3)
- x. Install new boot (2) and retaining ring (1)
- 3. INSTALL BRAKE CONTROL VALVE, TM10-3930-660-20



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# **CHAPTER 11**

# WHEEL AND TIRE MAINTENANCE

# Section I DESCRIPTION AND DATA

# 11-1 GENERAL

This chapter covers maintenance procedures for the wheels and tires, and provides general description and design data.

# 11-2 DESCRIPTION AND DATA

- a. <u>Tires</u> All four tires are identical in size and type (17 50-25 X 12 ply L-2) Recommended inflation pressure is higher for the front tires (45 psi) than for the rear tires (40 psi), however, because of the additional load on the front end.
- b. Wheels The wheels are of four-piece construction, each consisting of a wheel (rim), a flange, a locking ring and an Oring The Oring provides a seal against air leakage The flange, locking ring and Oring are placed to the inside when wheel is mounted

# Section II WHEEL AND TIRE MAINTENANCE PROCEDURES

# WHEEL AND TIRE MAINTENANCE TASK SUMMARY

TASK PARA	PROCEDURES	PAGE NO
	Tire - Repair (Refer to TM9-2610-200-14)	

11-1/(11-2 Blank)

#### **CHAPTER 12**

#### STEERING SYSTEM MAINTENANCE

# **Section I DESCRIPTION AND DATA**

# 12-1

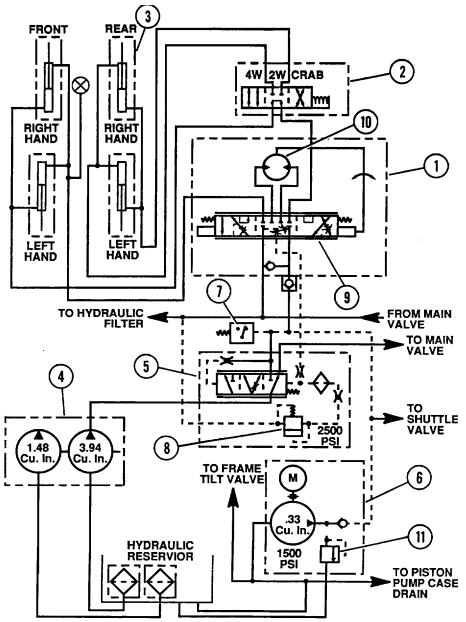
This chapter covers maintenance procedures for the steering system components, as well as principles of operation.

#### 12-2 PRINCIPLES OF OPERATION

- a. <u>System Components</u> The steering system components include steering valve (1), steer select valve (2) and four steering hydraulic cylinders (3) Additional, related components include the large (3 94 cu in ) section of dual gear pump (4) and priority valve (5). Making up the emergency steering system are an electric motor driven pump (6) and pressure switch (7). Pressure switch (7) senses hydraulic pressure in the main steering circuit and closes to turn on the emergency steering pump motor and a warning light in the cab when main system pressure drops to below approximately 75 psi
- b. Normal System Operation Hydraulic flow from the large section of dual gear pump (4) is directed to the inlet port of priority valve (5) The function of priority valve (5) is to ensure that sufficient oil flow goes to steering valve (1) to permit normal steering in the event that any attachment functions are being operated at the same time that steering is occurring. The priority valve (5) will deprive the attachment functions of oil flow in order to maintain adequate flow for steering. Component overpressure protection is provided by relief valve (8) which is built into priority valve (5).

As long as the steering wheel is not being turned, sleeve and spool assembly (9) remains centered and gerotor (10) remains stationary. Priority valve (5) will then direct pump flow to the main control valve The pressure resulting from the blocking condition of the centered steering valve sleeve and spool assembly (9) keeps priority valve (5) shifted to the right (as shown) to permit flow to the main valve. The steering cylinders (3) are held stationary by trapped oil in the lines.

Turning the steering wheel in either direction will cause the spool in sleeve and spool assembly (9) to rotate with respect to the sleeve. As this happens, oil is allowed to flow through passages in sleeve and spool assembly (9) to gerotor (10) This oil flow causes the gear in gerotor (10) to rotate, directing flow back to sleeve and spool assembly (9). The redirected flow now exits sleeve and spool assembly (9) via the proper work port and goes to steer select valve (2) Steer select valve (2) ports oil flow to steering cylinders (3) according to the selected steering condition (two-wheel, four-wheel or crab). If two-wheel steering has been selected, only the two front steering cylinders (3) are supplied If four-wheel steering or crab steering has been selected, all four steering cylinders are supplied



As steering cylinders (3) move in one direction, exhaust oil from the other ends is returned to the reservior through ports of steer select valve (2) and sleeve and spool assembly (9) and through the hydraulic filter (not shown).

c <u>Emergency Steering Function</u> Emergency steering pump (6) is powered by an electric motor and can supply a flow of oil to the steering system independently of the main hydraulic system. If main steering hydraulic pressure is lost or drops below a level of 75 psi, pressure switch (7) will close and complete a circuit to energize the emergency steering pump motor. Emergency steering pump flow bypasses priority valve (8) and goes directly to the inlet port of steering valve (1) A 1500 psi relief valve (11) is used to protect the emergency steering pump (6) and other circuit components against overpressure.

# Section II STEERING MAINTENANCE SYSTEM PROCEDURES

# STEERING SYSTEM MAINTENANCE TASK SUMIARY

TASK PARA	PROCEDURES	PAGE NO
12-3 12-4	Steering Knuckle - Replace/Adjust Emergency Steering Pump - Repair	12-4
12-5 12-6	Steering Control Valve - Repair Tie Rod - Replace	12-7 12-8 12-13

# 12-3 STEERING KNUCKLE - REPLACE/ADJUST

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation
- e. Adjustment

# Initial Setup

#### Tools

Tool kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

Planetary wheel ends removed, paras 8-6, 9-6 Tie rod removed, para 12-6

# Materials/Parts

Grease (App B, Item 11) Loctite 271 (App B, Item 43)

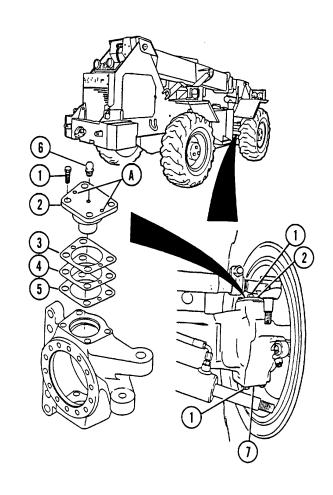
# **REMOVAL**

- MARK STEERING KNUCKLE CAPS UPPER
   (2) AND LOWER (7) CAPS ARE NOT INTERCHANGEABLE.
- 2. REMOVE FOUR CAPSCREWS (1) FROM EACH STEERING KNUCKLE CAP (2 AND 7).
- 3. INSTALL JACKING SCREWS IN HOLES A. TIGHTEN JACKING SCREWS TO LOOSEN CAPS (2 AND 7).

# **NOTE**

Do not mix upper and lower shims Keep shims together as a set for assembly

- 4 REMOVE LOWER STEERING KNUCKLE CAP (7), THRUST WASHER (8) AND SHIMS (9, 10 AND 11).
- 5 REMOVE UPPER STEERING KNUCKLE CAP (2) AND SHIMS (3, 4 AND 5).
- 6 REMOVE GREASE FITTINGS (6) FROM STEERING KNUCKLE CAPS (2 AND 7), IF NECESSARY.



# 12-3 STEERING KNUCKLE - REPLACE/ADJUST (Cont'd)

- 7. REMOVE STEERING KNUCKLE (12) FROM END OF AXLE .
- 8. REPEAT STEPS 1-5 FOR OTHER SIDE.

# **CLEANING**

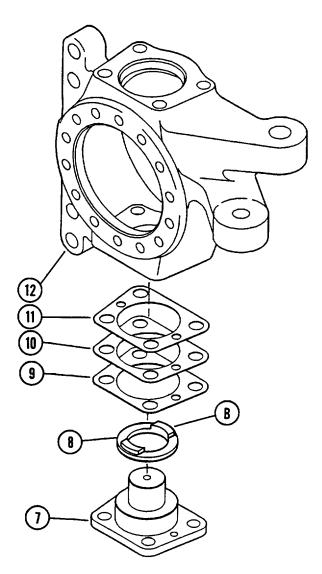
See Cleaning Instructions, para 2-10.

#### **INSPECTION**

See Inspection Instructions, para 2-11.

# **INSTALLATION**

- 1. IF REMOVAL WAS NECESSARY, INSTALLGREASE FITTING (6) IN CAPS (2 AND7)
- 2. APPLY GREASE IN BORES OF STEERING KNUCKLE FOR CAPS
- 3. INSTALL STEERING KNUCKLE (12) END OF AXLE
- 4. INSTALL STEERING KNUCKLE CAP (7)
  - a. Apply grease to groove face of thrust washer (8).
  - b. Install shims (9, 10 and 11)
    and thrust washer (8) on lower
    steering knuckle cap (7) Tabs
    (B) on thrust washer must be up.
  - c. Install lower cap assembly Ensure that thrust washer (8) tabs engage slots in end of axle housing before final tightening of capscrews (1).
  - d. Apply Loctite 271 to threads of capscrews (1) Tighten capscrews (1) to 85-115 lb ft.
- 5. INSTALL UPPER STEERING KNUCKLE CAP(2)
  - a. Install shims (3, 4 and 5) on upper steering knuckle cap (2).



# 12-3 STEERING KNUCKLE - REPLACE/ADJUST (Cont'd

- b. Install upper cap assembly
- c. Apply Loctite 271 to threads of capscrews (1) Tighten capscrews (1) to 85-115 lb ft
- 6. REPEAT STEPS 1-5 FOR OTHER STEERING KNUCKLE, IF NECESSARY
- 7. INSTALL PLANETARY WHEEL ENDS, PARAS 8-6, 9-6
- 8. INSTALL TIE ROD, PARA 12-6
- 9 ADJUST TIE ROD, TM10-3930-660-20

#### **ADJUSTMENT**

- 1 MEASURE VERTICAL END PLAY
  - If wheels are on ground: Use a feeler gauge to measure gap between upper steering knuckle cap shoulder and top machined surface of end of the axle housing
  - b. If wheels are removed (axle supported by blocks): Use a hydraulic jack or pry bar to push steering knuckle up until bottom of steering knuckle is tight against bottom of axle Measure gap as in STEP a
  - c Vertical end play may also be measured by checking maximum vertical movement of knuckle with a dial indicator
  - d Record measurement
- 2. VERTICAL END PLAY LIMITS:
  - a If end play is 0 013 inch or less, no adjustment is necessary
  - b If vertical end play exceeds 0 013 inch, go to STEP 3

# 3 ADJUST VERTICAL END PLAY

- a. Remove upper and lower steering knuckle caps Measure total current shim pack thickness (upper and lower shim packs combined)
- Subtract actual end play (value obtained in STEP 1) from total shim pack thickness obtained in STEP 2a Divide this result by
- c. Make new lower shim thickness the same value as calculated in STEP 2b If this thickness cannot be met exactly, choose nearest thicker shim pack
- d. Make new upper shim thickness the as value obtained in STEP 2b, plus 0 005 inch If this result cannot be met exactly, choose nearest thicker shim pack

# 12-4. EMERGENCY STEERING PUMP- REPAIR

#### This task covers:

- a. Disassembly
- b. Assembly

# **Initial Setup**

# **Tools**

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power.

#### **Equipment Condition**

Emergency steering pump removed.

# **DISASSEMBLY**

#### NOTE

The motor, pump/motor endhead and pump assemblies are not repairable. Each must be replaced as an assembly.

- 1. REMOVE FOUR CAPSCREWS (1) AND MOTOR ASSEMBLY (2).
- 2. REMOVE TWO CAPSCREWS (3) TO SEPARATE PUMP/MOTOR ENDHEAD (4) FROM PUMP (5).
- 3. REMOVE CHECK VALVE ASSEMBLY (6) AND RELIEF VALVE ASSEMBLY (7), IF NECESSARY.

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# **ASSEMBLY**

- 1. IF REMOVAL WAS NECESSARY, INSTALL RELIEF VALVE ASSEMBLY (7) AND CHECK VALVE ASSEMBLY (6).
- 2. INSTALL PUMP/MOTOR ENDHEAD (4) TO PUMP (5). INSTALL TWO CAPSCREWS (3).
- 3. INSTALL PUMP/MOTOR ENDHEAD (4) TO MOTOR ASSEMBLY (2). INSTALL FOUR CAPSCREWS (1).

#### 12-5. STEERING CONTROL VALVE - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# Initial Setup

Tools

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

Emergency steering control valve removed, TM10-3930-660-20.

# Materials/Parts

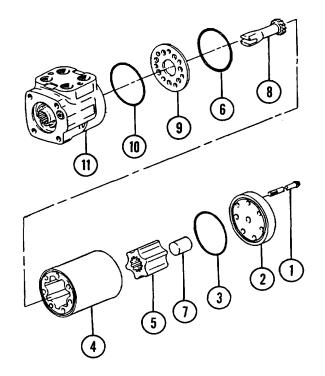
Hydraulic Oil (App. B, Item 35) Lint Free Rags (App. B Item 38) Seal (3, 6, 10, 22, 24, 26)

# **DISASSEMBLY**

# **CAUTION**

Care should be taken not to contaminate emergency steering pump during disassembly. Dirt and other foreign substances should be removed from surrounding area and pump before disassembling. Failure to follow this precaution will cause part damage.

- PLACE LINT FREE TOWELS OVER JAWS OF VISE TO PREVENT DAMAGE TO STEERING CONTROL VALVE.
- 2. PLACE STEERING CONTROL VALVE IN A VISE, METER END UP. DO NOT OVERTIGHTEN VISE.
- 3. DISASSEMBLE STEERING CONTROL VALVE (1-28).
  - a. Remove seven capscrews (1).
  - b. Remove end cap (2).
  - c. Remove and discard seal (3) from end cap (2).



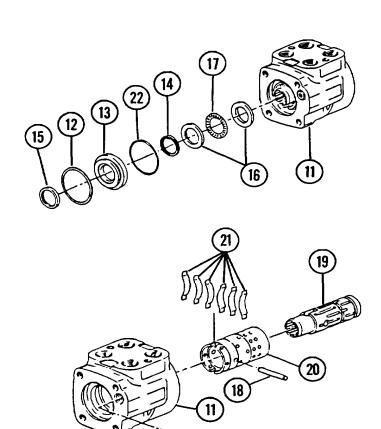
# 12-5. STEERING CONTROL VALVE - REPAIR (Cont'd)

- d. Remove gerotor housing (4) and star (5). Do not drop star (5).
- e. Remove and discard seal (6) from gerotor housing (4).
- f. Remove spacer (7).
- g. Remove drive (8).
- h. Remove spacer plate (9).
- i. Remove and discard seal (10) from valve housing (11).
- Reverse valve housing (11) by turning over and reclamp. Remove ring (12).
- k. Remove seal gland bushing (13).
- I. Remove quad ring seal (14) and seal (15).
- m. Remove two bearing races (16) and thrust bearing (17).
- n. Remove items 18, 19, and 20 as an assembly.
- Remove centering pin (18) from spool (19) and sleeve (20) assembly.

# **CAUTION**

Do not bind spool (19) and sleeve (20) in valve housing (11). Failure to follow this precaution will cause part damage.

- p. Push spool (19) out of sleeve (20). Rotate spool (19) slowly to remove it from housing (11).
- q. Remove centering springs (21) if necessary.
- r. Remove and discard seal (22).



# 12-5. STEERING CONTROL VALVE - REPAIR (Cont'd)

s. Remove set screw (23), seal (24), seat (25), seal (26), check ball (27) and retainer (28). Discard seals (24 and 26).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

#### NOTE

Wipe all sealing surfaces on pump clean and dry. Apply film of clean hydraulic oil to all seals, except quad ring seal (14), as they are installed.

- 1. ASSEMBLE STEERING CONTROL VALVE (1-28).
  - a. Install retainer (28), check ball(27), new seal (26), seat (25),new seal (24) and setscrew (23).
  - b. Install centering springs (21) in sleeve (20).
  - c. Assemble spool (19) and sleeve (20) so that spring slots line up at same end. Rotate spool (19) when sliding parts together.

    Spool (19) should rotate smoothly in sleeve (20) with fingertip force applied at spline end.
  - d. Install pin (18) through spool (19) and sleeve (20) assembly until it is flush at both sides of sleeve (20).

# 12-5. STEERING CONTROL VALVE - REPAIR (Cont'd)

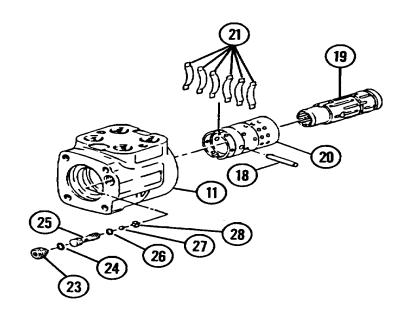
# **CAUTION**

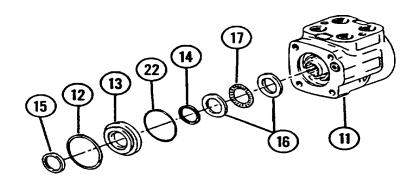
Use care when installing spool (19) and sleeve (20) assembly to prevent shifting of parts. Failure to follow this precaution will cause part damage.

e. Position spool (19) and

sleeve

- (20) assembly so that spline end of spool (19) enters valve housing (11) end opposite steering column side. Push spool (19) and sleeve (20) assembly into valve housing (11) until flush at gerotor housing end. Do not pull assembly beyond this point to prevent pin (18) from dropping into discharge groove of housing (11).
- f. Check for free rotation of the spool (19) and sleeve (20) assembly by turning with light fingertip force at spline end.
- g. Install two bearing races (16) and thrust bearing (17) over spool (19).
- h. Install new seal (22) into valve housing (11).
- i. Do not lubricate quad ring seal 14). Install quad ring seal (14) and seal (15) in seal gland bushing (13).
- j. Install seal gland bushing (13) over spool (19) in valve housing (11).
- k. Install retaining ring (12).
- I. Turn valve housing (11) over.
- m. Install new seal (10) in valve housing (11).





# 12-5. STEERING CONTROL VALVE - REPAIR (CONT'D)

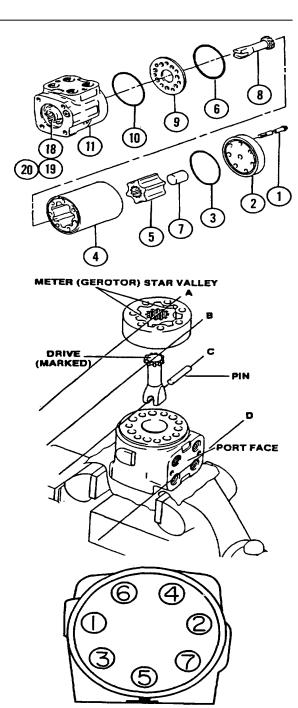
- n. Install space plate (9). Align capscrew holes between spacer plate (9) and tapped holes in valve housing (11)
- o. Rotate spool (19) and sleeve (20) assembly until pin (18) is parallel with port face.
- p. Install drive (8). Ensure that drive (8). Engages pin (18).
- q. Install new seal (6) in gerotor housing (4).
- r. Install gerotor housing (4). Place gerotor housing (4) with seal (6) mating to spacer plate (9). Align valleys between
  - (4). Note parallel relationship between lines A, B, C,

D.

- s. Install star (5). Engage star (5) and drive (8) without distubing relationship of components.
- t. Install spacer (7) in star (5).
- u. Install new seal (3) in end cap (2).
- v. Install end cap (2) on gerotor housing (4) and align

holes.

w. stall seven capscrews (1) in end cap (2). Pretighten capscrews (2) to 150 lb. In., then tighten to a torque of 275 lb. in. In sequence shown.



# 12-6 TIE ROD - REPLACE

This task covers:

a Removal

b Installation

# **Initial Setup**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Soft Mallet

# **Equipment Condition**

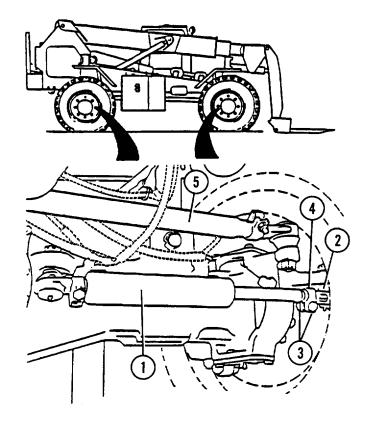
Vehicle parked on level ground Parking brake applied Front or rear axle removed, para 8-3 and 9-3 Wheels removed, TM10-3930-660-20 Materials/Parts Cotter Pin (7)



The following procedures apply to both the front and rear tie rods.

# **REMOVAL**

- 1 TO PROVIDE WORK ROOM, DISCONNECT ROD ENDS OF BOTH STEERING CYLINDERS (1) FROM BALL JOINTS (2) SWING CYLINDERS (1) OUT TO PROVIDE WORK ROOM.
  - Count and record number of threads visible at rod end of steering cylinder (1) between ball joint (2) and end of threads on rod
  - b. Loosen nut and capscrew (3) of clamp (4)
  - Unscrew rod end of steering cylinder (1) from socket of ball joint (2) until rod end is disengaged



# 12-6 TIE ROD - REPLACE (Cont'd)

- d. Swing cylinder (1) away from axle to provide sufficient work room
- e. Repeat steps a d for other steering cylinder
- 2. REMOVE TIE ROD (5) FROM SPINDLE KNUCKLE (6)
  - a. Remove and discard cotter pin (7) from tie rod end
  - b. Loosen castle nut (8)
  - c. Tap castle nut (8) with a soft mallet to loosen tie rod end from spindle knuckle (6)
  - d. Remove castle nut (8)
  - e. Repeat steps a d for other end of tie rod (5)
  - f. Remove tie rod (5) from vehicle

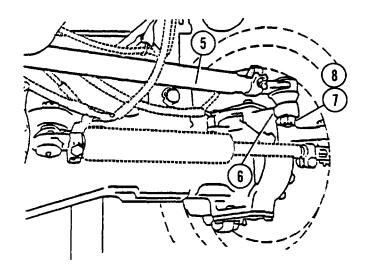
# **INSTALLATION**

1. CONNECT TIE ROD TO SPINDLE KNUCKLE (6)

# **NOTE**

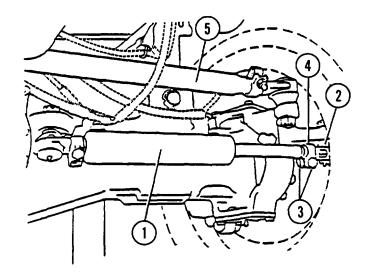
It may be necessary to turn the wheels slightly when installing tie rod ends

- a. Position tie rod (5) ends into holes of steering spindle knuckles(6)
- b. Install castle nuts (8) on each tie rod end Tighten castle nuts (8) to a torque of 200 to 250 lb ft
- Further tighten castle nuts (8) as necessary until notches on each nut
   (8) align with cotter pin hole on each tie rod end
- d. Install new cotter pins (7)
  through notches on castle nuts
  (8) and through holes on tie rod ends



# 12-6 TIE ROD - REPLACE (Cont'd)

- 2. CONNECT ROD ENDS OF STEERING CYLINDERS (1) TO BALL JOINTS (2)
  - Swing cylinder (1) toward axle until cylinder rod end is aligned with socket of ball joint (2)
  - b. Screw cylinder rod end into socket of ball joint (2) until number of threads visible is the same as noted in step la of removal section
  - c. Tighten nut and capscrew (3) of clamp (4) to 50-65 lb ft
  - d. Repeat steps a c for other steering cylinder
- 3. REMOVE BLOCKING MATERIAL FROM WHEELS OF VEHICLE
- 4. ADJUST TIE ROD, TM10-3930-660-20



#### **CHAPTER 13**

# FRAME AND TOWING ATTACHENT MAINTENHNCA

#### Section I. DESCRIPTION AND DATA

# 13-1. **GENERAL**.

This chapter covers maintenance procedures for the frame and towing attachment components, as well as descriptive information.

# 13-2. DESCRIPTION AND DATA.

The frame is constructed of heavy gauge plate steel. All joints are welded. The boom, counterweight and both axles are pinned to the frame. The cab and body components are secured to the frame using a variety of capscrews, nuts and washers.

Openings in the frame provide access to the transmission and engine. Sheet metal covers are attached to the frame over these access openings. The fuel/hydraulic tank, cab and radiator guard are also attached to the frame.

# Section II. FRAME AND TOWING ATTACHMENT MAINTENANCE PIKOWRES

# FRAME AND TOWING ATTACHMENT MAINTENANCE TASK SUMMARY

TASK PARA.	PROCEDURES	PAGE NO.
13-3	Frame Assembly - Repair	13-2

# 13-3. FRAME ASSEMBLY - REPAIR

# This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# Initial Setup

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Machine Shop Field Maintenance Basic, Less Power

Tool Kit, Body and Fender Repair

# **Equipment Condition**

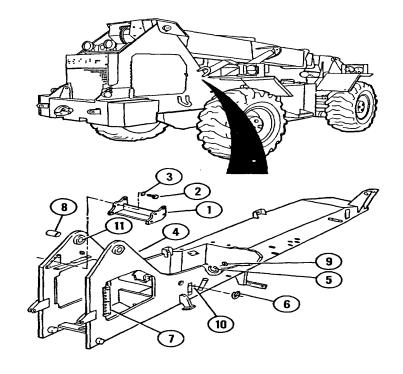
Back-up alarm and rear service floodlights removed, TM10-3930-660-20.

# Materials/Parts

Bushing(8)
Conduit(5)
Conduit(6))
Hinge (7)
Lockwashers (3)
Loctite 271 (App B Item 43))

# **DISASSEMBLY**

- 1. REMOVE CROSS MEMBER (1).
  - a. Remove eight capscrews (2) and eight lockwashers (3) from crossmember (1). Discard lockwasher (3).
- b. Remove cross member (1) from frame (4).
- 2. REMOVE CONDUIT (5) FROM HOLE (9) IN FRAME (4). DISCARD CONDUIT (5).
- 3. REMOVE CONDUIT (6) FROM HOLE (10) IN FRAME (4). DISCARD CONDUIT (6).
- 4. REMOVE HINGE (7) FROM FRAME (4).
  - a. Remove engine access door, TM10-3930-660-20.
  - Measure location of hinge (7) in frame cutout for door. Record location.



# 13-3. FRAME ASSEMBLY - REPAIR (Cont'd)

- c. Break welds attaching hinge (7) to frame (4).
- d. Remove hinge (7) and discard.
- e. Use a grinder or file to remove old weld material from frame (4).
- 5. REMOVE SELF-ALIGNING BUSHING (8).
  - a. Remove boom, TM10-3930-660-20.
  - b. Use a hammer and suitable driver to remove bushing (8) from boom pivot pin hole (11).
  - c. Discard bushing (8).

# **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

# **ASSEMBLY**

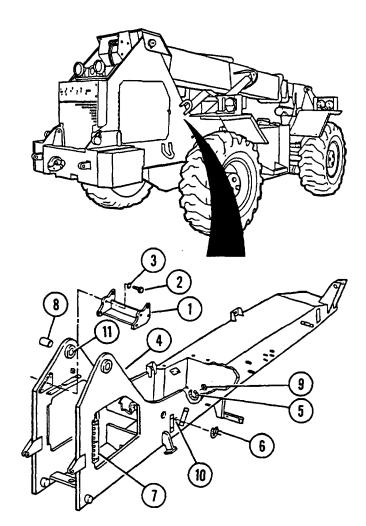
- 1. INSTALL NEW SELF-ALIGNING BUSHING (8).
  - Use a hammer and suitable driver to install new self-aligning bushing (8).
  - b. Install boom, TM10-3930-660-20.
- 2. INSTALL NEW DOOR PANEL HINGE (7).
  - a. Position new hinge (7) on frame, using measurements taken at disassembly.
  - b. Hold hinge (7) in position, using a suitable clamp.

# 13-3. FRAME ASSEMBLY - REPAIR (Cont'd)

# **CAUTION**

Do not weld door side of hinge (7) to frame (4). Welding incorrect half of hinge (7) to frame (4) will result in damage to frame (4) and hinge (7).

- c. Weld hinge (7) to frame (4) at several points along pin side, TM9-237.
- 3. INSTALL NEW CONDUIT (6) IN HOLE (10) IN FRAME (4).
- 4. INSTALL NEW CONDUIT (5) IN HOLE (9) IN FRAME (4).
- 5. INSTALL CROSS MEMBER (1).
  - a. Install cross member (1) onto frame (4) and secure with eight capscrews (2) and eight new lockwashers (3).
  - b. Apply Loctite 271 to threads of capscrews (2).
  - c. Torque capscrews (2) to 210 lb. ft.



#### **CHAPTER 14**

# **BODY, CAB AND HOOD MAINTENANCE**

#### Section I. DESCRIPTION AND DATA

# 14-1. GENERAL.

This chapter covers maintenance procedures for the body, cab and hood components, as well as component descriptions and data.

#### 14-2. DESCRIPTION AND DATA.

- a. <u>.Cab</u> The cab is attached to the left side of the frame. It is fully enclosed and heated. Sound suppression panels are installed for the purpose of reducing outside noises. The cab door is split horizontally, allowing the upper portion to be propped open for cab ventilation. Additional ventilation is provided by a skylight and the rear window, both of which can be propped open. The cab design incorporates both rollover protection (ROPS) and fall over protection (FOPS).
- b. <u>Seat</u>. The operator's seat is a fixed position seat, with a one-piece frame and separate cushions for seat and back. Seat belt is anchored to the seat frame.
- c. Fenders. Fenders are provided for all four wheels. The frame mounting brackets are attached to the vehicle frame. Light brackets are attached to the tops of the fenders.

# Section II. BODY, CAB AND HOOD MAINTENANCE PROCEDURES BODY, CAB, AND HOOD MAINTENANCE TASK SUMMARY

TASK PARA.	PROCEDURES	PAGE NO.
14-3	Cab Assembly with ROPS/FOPS - Replace/Repair	14-2
14-4	Sound Suppression Panels - Replace	14-15
14-5	Seat Assembly - Repair	14-18

# 14-3. CAB ASSEMBLY WITH ROPS/POPS - REPLACE/REPAIR

# This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

# **Initial Setup**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Shop Equipment, Machine Shop: Field Maintenance, Basic, Less Power

Tool Kit, Body and Fender Repair

Lifting Device (Capacity 1 ton)

Cap and Plug Set

# **Equipment Condition**

Cooling system drained, TM10-3930-660-20. Hydraulic system drained, TM10-3930-660-20. Batteries removed, TM10-3930-660-20. Transmission cover removed, TM10-3930-660-20. Materials/Parts

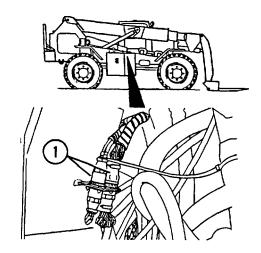
Container, 1 Gal Loctite 242 (App. B, Item 39) Starwashers (14, 15) Tags (App. B, Item 52)

Personnel Required
Two Personnel

# **REMOVAL**

# 1. DISCONNECT ELECTRICAL WIRING.

- a. Tag and disconnect two cab wiring harness connectors (1).
- b. Tag and disconnect wiring at STE/ICE shunt, TM10-3930-660-20.



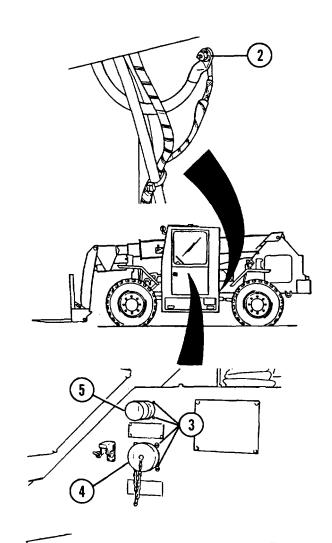
14-2

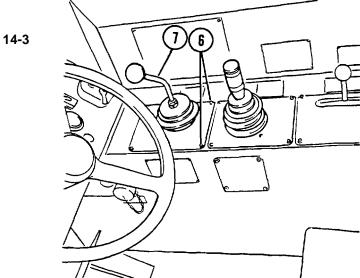
# 14-3. CAB ASSEMBLY WITH ROPS/POPS - REPLACE/REPAIR (Cont'd)

c. Tag and disconnect wiring at stud ground connection (2) on vehicle frame.

d. Remove screws (3) securing STE/ICE diagnostic receptacle (4) and resistor module receptacle (5).

e. Remove screws (6) and pull up on cover/hydraulic joystick control assembly (7) to allow access behind side console.

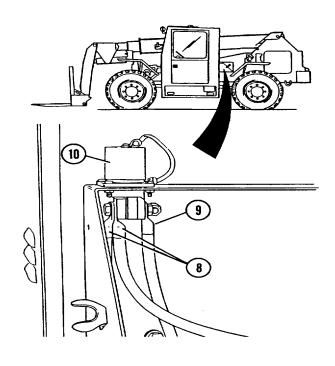




- f. Reach inside console and position receptacles (4) and (5) so they can be pulled from bottom of cab.
- g. Pull receptacles (4) and (5) from bottom of cab.
- h. Disconnect cables (8) and (9) from NATO slave receptacle (10).
- 2. DISCONNECT ACCELERATOR CABLE AT ENGINE, TM10-3930-660-20.
- 3. DISCONNECT TRANSMISSION CABLES AT TRANSMISSION, TM10-3930-660-20.
- 4. DISCONNECT PARKING BRAKE CABLE AT PARKING BRAKE LEVER IN CAB, TM10-3930-660-20.
- 5. DISCONNECT HEATER HOSES AT TEMPERATURE CONTROL VALVE AND HEATER, TM10-3930-660-20.

# **WARNING**

Hydraulic oil in system can be under pressure over 1,500 psi with engine and pump OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in hydraulic With engine OFF and hydraulic attachments on ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.



# **CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of hydraulic system could result in system. premature failure.

## NOTE

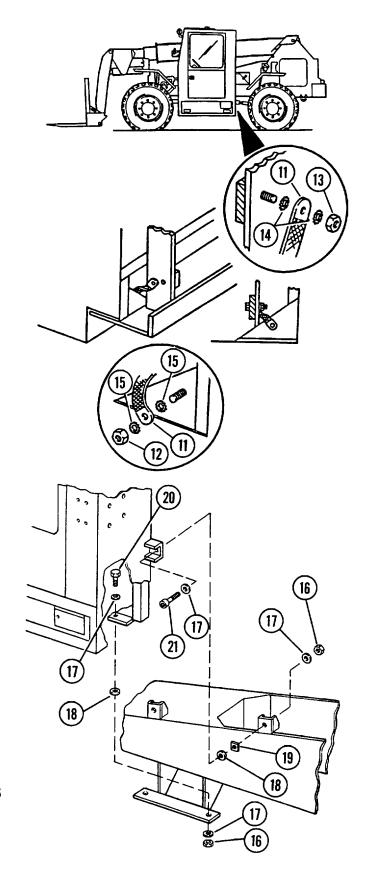
If more than one hydraulic line is removed, identify lines assure proper installation. Use suitable container to system.

## 6. DISCONNECT HYDRAULIC LINES.

- a. Disconnect two hydraulic steering control lines at priority valve, TM10-3930-660-20.
- b. Disconnect six hydraulic lines from hydraulic joystick, four at boom control valve, one at shuttle valve, TM10-3930-660-20.
- c. Disconnect one hydraulic line from transmission disconnect master cylinder at transmission control valve, TM10-3930-660-20.
- d. Disconnect four hydraulic brake lines; one at each brake tee and two at frame tilt/brake relief valve, TM10-3930-660-20.
- e. Disconnect hydraulic line at tee of all four steering cylinders, TM10-3930-660-20.
- f. Disconnect hydraulic lines at frame tilt cylinder port, TM10-3930-660-20.
- g. Disconnect hydraulic line at hydraulic piston pump, TM10-3930-660-20.
- 7. REMOVE GROUNDING STRAPS (11).

Remove nuts (12) and (13), grounding strap (11), and starwashers (14) and (15). Discard starwashers (14) and (15).

- 8. SECURE CAB USING A SUITABLE HOIST AND SLING.
- 9. REMOVE FOUR NUTS (16), EIGHT FLATWASHERS (17), TWO WASHERS (19), FOUR RUBBER WASHERS (18), TWO CAPSCREWS (20), AND TWO CAPSCREWS (21).



10. REMOVE CAB ASSEMBLY. HAVE ASSISTANT CHECK FOR ANY ELECTRICAL OR HYDRAULIC CONNECTIONS WHICH MIGHT HAVE BEEN MISSED AND NEED TO BE DISCONNECTED.

## **CAUTION**

When placing cab on stands, be sure no hoses or wires are between cab and stands. Failure to follow this procedure may result in damage to hoses or wiring.

11. PLACE CAB ON SUITABLE STANDS.

# **DISASSEMBLY**

## **NOTE**

If necessary, components may be removed from old cab and installed on new cab assembly.

- 1. REMOVE TURN SIGNAL SWITCH, TM10-3930-660-20.
- 2. REMOVE STEERING WHEEL AND COLUMN, TM10-3930-660-20.
- 3. REMOVE STEERING CONTROL VALVE, TM10-3930-660-20.
- 4. REMOVE TRANSMISSION SHIFTER AND CABLES, TM10-3930-660-20.
- 5. REMOVE BACK-UP ALARM SWITCH, TM10-3930-660-20.
- 6. REMOVE GAGES AND METERS, TM10-3930-660-20.
- 7. REMOVE MAIN LIGHT SWITCH. TM10-3930-660-20.
- 8. REMOVE START/RUN CONTROL, TM10-3930-660-20.

- 9. REMOVE HORN BUTTON, TM10-3930-660-20.
- 10. REMOVE FORK AUTOLEVELER SWITCH, TM10-3930-660-20.
- 11. REMOVE SPOTLIGHTS, TM10-3930-660-20.
- 12. REMOVE WARNING LIGHTS, TM10-3930-660-20.
- 13. REMOVE SPOTLIGHT SWITCHES, TM10-3930-660-20.
- 14. REMOVE CIRCUIT BREAKERS, TM10-3930-660-20.
- 15. REMOVE UNDERDASH RELAYS, TM10-3930-660-20.
- 16. REMOVE STEERING SELECTOR VALVE, TM10-3930-660-20.
- 17. REMOVE BRAKE AND TRANSMISSION DISCONNECT PEDALS, TM10-3930-660-20.
- 18. REMOVE TRANSMISSION DISCONNECT VALVE, TM10-3930-660-20.
- 19. REMOVE BRAKE CONTROL VALVE, TM10-3930-660-20.
- 20. REMOVE BRAKE ACCUMULATOR, TM10-3930-660-20:
- 21. REMOVE ACCELERATOR PEDAL AND CABLE, TM10-3930-660-20.
- 22. REMOVE PARKING BRAKE LEVER AND CABLE, TM10-3930-660-20.
- 23. REMOVE HYDRAULIC JOYSTICK CONTROLLER, TM10-3930-660-20.
- 24. REMOVE FRAME TILT VALVE, TM10-3930-660-20.

- 25. REMOVE WATER TEMPERATURE CABLE, TM10-3930-660-20.
- 26. REMOVE ENGINE PRIMER BUTTON, TM10-3930-660-20.
- 27. REMOVE HEATER FAN SWITCH, TM10-3930-660-20.
- 28. REMOVE SEAT AND SEAT BELT, TM10-3930-660-20.
- 29. REMOVE CAB HEATER, HOSES, LINES AND FITTINGS, TM10-3930-660-20.
- 30. REMOVE FIRE EXTINGUISHER AND BRACKET, TM10-3930-660-20.
- 31. REMOVE MANUAL HOLDER, TM10-3930-660-20.
- 32. REMOVE WINDSHIELD WASHER ASSEMBLY, TM10-3930-660-20.
- 33. REMOVE DATA PLATES, TM10-3930-660-20.
- 34. REMOVE ELECTRIC JOYSTICK CONTROLLER, TM10-3930-660-20.
- 35. REMOVE CAB LIGHTS, TM10-3930-660-20.
- 36. REMOVE FRONT AND REAR WINDSHIELD WIPER ASSEMBLIES, TM10-3930-660-20.
- 37. REMOVE WIRE HARNESS, TM10-3930-660-20.
- 38. REMOVE NEUTRAL SAFETY SWITCH, TM10-3930-660-20.
- 39. REMOVE BATTERY BOX, TM10-3930-660-20.
- 40. REMOVE TOOL BOX LATCH, TM10-3930-660-20.
- 41 REMOVE WINDSHIELD AND WINDOWS, TM10-3930-660-20.

- 42. REMOVE CAB DOOR, TM10-3930-6<sup>60-20.</sup>
- **4**3. REMOVE SOUND SUPPRESSION PANELS, PARA. 14-4.
- 44. REMOVE CAB LEVEL GAGE, TM10-3930-660-20
- 45. REMOVE HEATER CONTROL VALVE, TM10-3930-660-20.

# **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

## **ASSEMBLY**

- 1. INSTALL HEATER CONTROL VALVE, TM10-3930-660-20.
- INSTALL CAB LEVEL GAGE, TM10-3930-660-20.
- INSTALL NEW SOUND SUPPRESSION PANELS INTO NEW CAB, PARA. 14-4.
- 4. INSTALL CAB DOOR, TM10-3930-660-20.
- 5. INSTALL WINDSHIELD AND WINDOWS, TM10-3930-660-20.
- 6. INSTALL TOOL BOX LATCH INTO NEW CAB, TM10-3930-660-20.
- 7 INSTALL BATTERY BOX INTO NEW CAB, TM10-3930-660-20.
- 8. INSTALL NEUTRAL SAFETY SWITCH INTO NEW CAB, TM10-3930-660-20.
- 9. INSTALL WIRE HARNESS INTO NEW CAB, TM10-3930-660-20.
- 10. INSTALL FRONT AND REAR WINDSHIELD WIPER ASSEMBLIES INTO NEW CAB, TM10-3930-660-20.

- 11. INSTALL CAB LIGHTS INTO NEW CAB, TM10-3930-660-20.
- 12. INSTALL ELECTRIC JOYSTICK CONTROLLER INTO NEW CAB, TM10-3930-660-20.
- 13. INSTALL DATA PLATES INTO NEW CAB, TM10-3930-660-20.
- INSTALL WINDSHIELD WASHER ASSEMBLY INTO NEW CAB, TM10-3930-660-20.
- 15. INSTALL MANUAL HOLDER INTO NEW CAB, TM10-3930-660-20.
- 16. INSTALL FIRE EXTINGUISHER AND BRACKET INTO NEW CAB, TM10-3930-660-20.
- 17. INSTALL CAB HEATER, HOSES, LINES AND FITTINGS INTO NEW CAB, TM10-3930-660-20.
- 18. INSTALL SEAT AND SEAT BELT INTO NEW CAB, TM10-3930-660-20.
- 19. INSTALL HEATER FAN SWITCH, TM10-3930-660-20.
- 20. INSTALL ENGINE PRIMER BUTTON, TM10-3930-660-20.
- 21. INSTALL WATER TEMPERATURE CABLE, TM10-3930-660-20.
- 22. INSTALL FRAME TILT VALVE INTO NEW CAB, TM10-3930-660-20.
- 23. INSTALL HYDRAULIC JOYSTICK CONTROLLER INTO NEW CAB, TM10-3930-660-20.
- 24. INSTALL PARKING BRAKE LEVER AND CABLE INTO NEW CAB, TM10-3930-660-20.
- 25. INSTALL ACCELERATOR PEDAL AND CABLE INTO NEW CAB, TM10-3930-660-20.
- 26. I NSTALL BRAKE ACCUMULATOR INTO NEW CAB, TM10-3930-660-20.

- 27. INSTALL BRAKE CONTROL VALVE INTO NEW CAB, TM10-3930-660-20.
- 28. INSTALL TRANSMISSION DISCONNECT VALVE INTO NEW CAB, TM10-3930-660-20.
- 29. INSTALL BRAKE AND TRANSMISSION DISCONNECT PEDALS INTO NEW CAB, TM10-3930-660-20.
- 30. INSTALL STEERING SELECTOR VALVE INTO NEW CAB, TM10-3930-660-20.
- 31. INSTALL UNDERDASH RELAYS INTO NEW CAB, TM10-3930-660-20.
- 32. INSTALL CIRCUIT BREAKERS INTO NEW CAB, TM10-3930-660-20.
- 33. INSTALL SPOTLIGHT SWITCHES, TM10-3930-660-20.
- 34. INSTALL WARNING LIGHTS, TM10-3930-660-20.
- 35. INSTALL SPOTLIGHTS, TM10-3930-660-20.
- 36. INSTALL FORK AUTOLEVELER SWITCH, TM10-3930-660-20.
- 37. INSTALL HORN BUTTON, TM10-3930-660-20.
- 38. INSTALL START/RUN CONTROL, TM10-3930-660-20.
- 39. INSTALL MAIN LIGHT SWITCH INTO NEW CAB, TM10-3930-660-20.
- 40. INSTALL GAUGES AND METERS INTO NEW CAB, TM10-3930-660-20.
- 41. INSTALL BACK-UP ALARM SWITCH INTO NEW CAB, TM10-3930-660-20.
- 42. INSTALL TRANSMISSION SHIFTER AND CABLES INTO NEW CAB, TM10-3930-660-20.

- 43. INSTALL STEERING CONTROL VALVE INTO NEW CAB, TM10-3930-660-20.
- 44. INSTALL STEERING WHEEL AND COLUMN INTO NEW CAB, TM10-3930-660-20.
- 45. INSTALL TURN SIGNAL SWITCH INTO NEW CAB, TM10-3930-660-20.

## **INSTALLATION**

1. USE A HOIST AND SLING TO POSITION CAB ON VEHICLE.

## **NOTE**

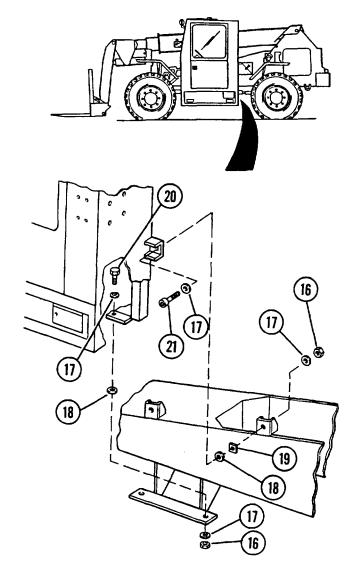
Apply Loctite 242 to threads of capscrews (20 and 21) as installed.

2. ALIGN CAB AND FRAME MOUNTING HOLES AND INSTALL TWO CAPSCREWS (21), TWO CAPSCREWS (20), EIGHT FLATWASHERS (17), TWO WASHERS (19), FOUR RUBBER WASHERS (18) AND FOUR NUTS (16).

## **NOTE**

Use washers (19) to shim cab so cab side plate to boom hoist cylinder anchor clearance with vehicle level and boom centered, is 2.75 inches minimum. Shim both upper cab mounts equally. Use as few washers (19) as possible. Do not overshim.

- 3. TIGHTEN CAB MOUNTING HARDWARE TO 640 LB. FT. OF TORQUE.
- 4. REMOVE HOIST AND SLING.
- 5. CONNECT HYDRAULIC LINES. USE TAGS PLACED ON LINES AT DISASSEMBLY TO ENSURE CORRECT CONNECTION.
- 6. CONNECT HEATER HOSES AT TEMPERATURE CONTROL VALVE AND HEATER, TM10-3930-660.
- 7. CONNECT PARKING BRAKE CABLE, TM10-3930-660.



- 8. CONNECT TRANSMISSION CABLE AT THE TRANSMISSION, TM10-3930-660.
- 9. CONNECT ACCELERATOR CABLE AT ENGINE,

TM10-3930-660.

10. CONNECT CABLES (8) AND (9) TO THE NATO SLAVE RECEPTACLE (10).

# **NOTE**

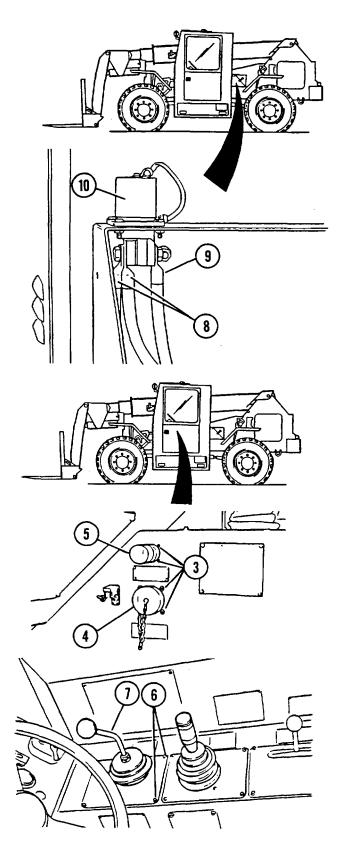
Apply Loctite 242 to threads of screws (6) as installed.

11. POSITION RECEPTACLES (4) AND (5) IN OPERATOR SIDE CONSOLE AND SECURE WITH SCREWS (3).

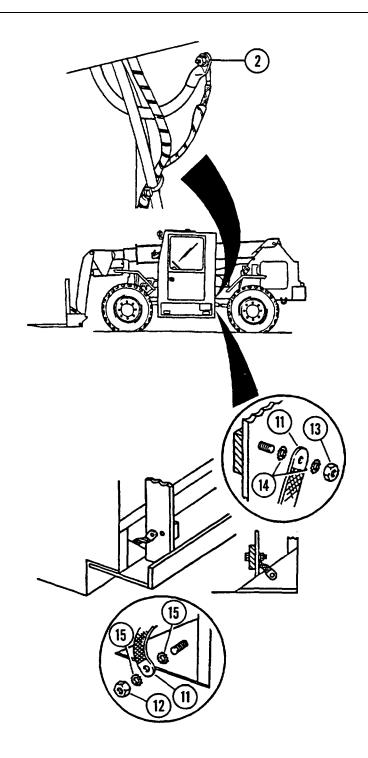
## **NOTE**

Apply Loctite 242 to threads of screws (3) as installed.

12. SECURE JOYSTICK CONTROL ASSEMBLY (7) WITH SCREWS (6).



- 13. CONNECT WIRING AT STUD GROUND CONNECTION (2) ON VEHICLE FRAME.
- 14. CONNECT WIRING AT STE/ICE SHUNT TM10-3930-660-20.
- 15. CONNECT CAB WIRING HARNESS CONNECTORS (1).
- 16. INSTALL GROUNDING STRAPS (11).
  - a. Install two new starwashers (15) and two new starwashers (14).
  - b. Install grounding strap (11) and two nuts (12) and (13). Tighten nuts (12) and (13) securely.



### 14-4. SOUND SUPRESSION PANELS - REPLACE

## This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

## Initial Setup

## **Tools Materials/Parts**

Tool Kit, Auto Mechanics

Adhesive (App. B, Item 1) Panels (1-10) REKOVAL

# **Equipment Condition**

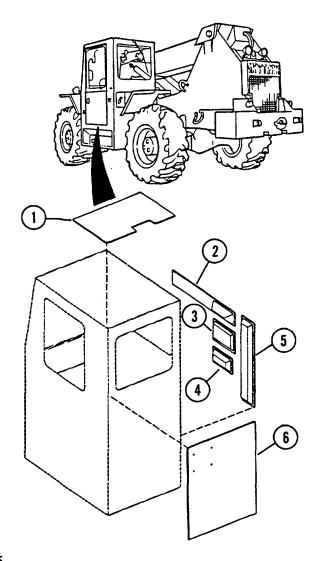
Seat removed, TM10-3930-660-20. Windshield washer reservoir removed, TM10-3930-660-20.

# **REMOVAL**

### NOTE

Sound supression panels are glued to vehicle. Use a knife or single edged razor blade to cut panels from vehicle. After removing panel, scrape away as much of old adhesive and panel material as possible. Remove remainder of old adhesive with cleaning solvent (refer to cleaning instructions, para.

- 1. REMOVE HEADLINER PANEL (1). DISCARD PANEL (1).
- 2. REMOVE RIGHT SIDEWALL UPPER PANEL (2). DISCARD PANEL (2).
- 3. REMOVE RIGHT SIDEWALL CENTER PANEL (3). DISCARD PANEL (3).
- 4. REMOVE RIGHT SIDEWALL LOWER PANEL (4). DISCARD PANEL (4).
- 5. REMOVE RIGHT SIDEWALL REAR PANEL (5). DISCARD PANEL (5).
- 6. REMOVE REAR PANEL (6). DISCARD PANEL (6).



# 14-4. SOUND SUPRESSION PANELS - REPLCE (Cont'd)

- 7. REMOVE LEFT REAR SIDEWALL LOWER PANEL (7). DISCARD PANEL (7).
- 8. REMOVE LOWER DOOR PANEL (8). DISCARD PANEL (8).
- 9. REMOVE LEFT REAR SIDEWALL UPPER PANEL (9). DISCARD PANEL (9).
- 10. REMOVE UPPER DASH PANEL (10). DISCARD PANEL (10).

## **CLEANING**

See Cleaning Instructions, para. 2-10.

## **INSPECTION**

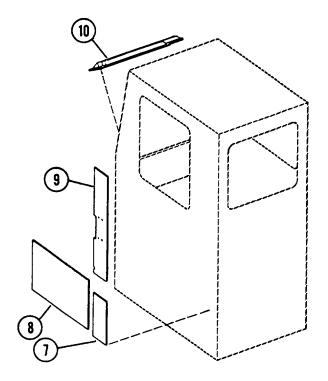
See Cleaning Instructions, para. 2-11.

# **INSTALLATION**

# **NOTE**

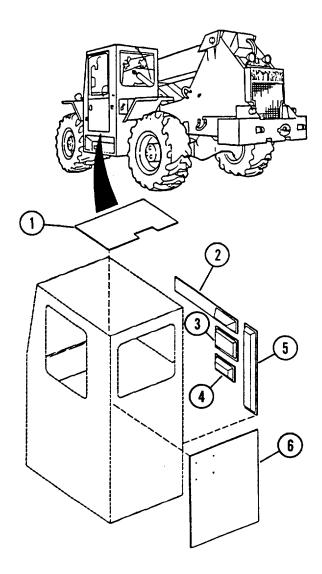
When installing sound supression panels, apply adhesive to both vehicle sheet metal and back of sound supression panel to be installed; position panel on vehicle and press into place.

- 1. INSTALL UPPER DASH PANEL (10).
- 2. INSTALL LEFT REAR SIDEWALL UPPER PANEL (9).
- 3. INSTALL LOWER DOOR PANEL (8).
- 4. INSTALL LEFT REAR SIDEWALL LOWER PANEL (7).
- 5. INSTALL REAR PANEL (6).
- 6. INSTALL RIGHT SIDEWALL REAR PANEL **(5).**
- 7. INSTALL RIGHT SIDEWALL LOWER PANEL (4).



# 14-4. SOUND SUPRESSION PANELS - REPLACE (Cont'd)

- 8. INSTALL RIGHT SIDEWALL CENTER PANEL (3).
- 9. INSTALL RIGHT SIDEWALL UPPER PANEL (2).
- 10. I NSTALL HEADLINER PANEL (1).



### 14-5. SEAT ASSEMBLY - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

## Initial Setup

**Tools Materials/Parts** 

Tool Kit Automotive Mechanics Shop Equipment Automotive Maintenance Common #2 Less Power Lockwashers (4) Loctite 242 (App. B, Item 41)

# **Equipment Condition**

Seat removed, TM10-3930-660-20.

## **DISASSEMBLY**

- 1. REMOVE SEAT BELT (1) BY REMOVING TWO CAPSCREWS (2), TWO NUTS (3), AND TWO LOCKWASHERS (4) WHICH RETAIN THE BELT (1). DISCARD LOCKWASHERS (4).
- 2. REMOVE SEAT CUSHIONS (5) AND (6) BY REMOVING FIVE CAPSCREWS (7) WHICH RETAIN SEAT CUSHIONS (5) AND (6).
- 3. REMOVE SEAT ADJUSTER (8) BY REMOVING FOUR CAPSCREWS (10) AND FOUR CUPWASHERS (11) FROM SEAT SHELL (9).

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

## **ASSEMBLY**

## **NOTE**

Apply Loctite 242 to threads of capscrews (10) as installed.

- 1. INSTALL FOUR CUPWASHERS (11), AND SEAT ADJUSTER (8) ONTO SEAT SHELL (9) AND RETAIN WITH FOR CAPSREWS (10)
- 9 3 4 6 1
- 2. INSTALL SEAT CUSHIONS (5) AND (6) AND RETAIN WITH FIVE CAPSCREWS (7).
- 3 . INSTALL SEAT BELT (1) AND RETAIN WITH TWO CAPSCREWS (2), TWO NUTS (3), AND TWO NEW LOCKWASHERS (4).

# **CHAPTER 15**

## **BODY AND CHASSIS ACCESSORY ITEMS MAINTENANCE**

## **Section I. DESCRIPTION AND DATA**

### 15-1. MAINTENANCE TASK SUMMARY.

This chapter covers maintenance procedures for the cab heater, as well as a functional description of the cab heater.

### 15-2. DESCRIPTION AND DATA.

- a. <u>Heater</u>. The heater is located beneath the operator's seat in the cab. Engine coolant is supplied to the heater core through flexible hoses. A pair of blowers draw air through the heater core where it extracts heat and discharges the heated air along the floor of the cab.
- b. <u>Heater Controls</u>. A manually operated valve located in the coolant supply line controls heating capacity of the heater by regulating the flow of coolant to the heater core. This valve can be fully closed to completely shut off coolant flow to the heater core. Control of this valve is by means of a push-pull knob located on the side console. Pulling up on the knob increases the heater temperature setting. Pushing down on the knob decreases the heater temperature setting.

A three-position switch, also located on the side console, controls heater blower speed. LOW position of the switch produces the slower speed and HIGH position produces the highest blower speed. The OFF position removes power from the heater blower motor and the motor shuts off.

## Section II. BODY AND CHASSIS ACCESSORY ITEMS MAINTENANCE PROCEDURES

# **BODY AND CHASSIS ACCESSORY ITEMS MAINTENANCE TASK SUMMARY**

TASK PARA	. PROCEDURES	PAGE NO.
15-3	24V Heater Assembly - Repair	15-2

## 15-3. 24V BEATER ASSEMBLY - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# Initial Setup

### **Tools**

Tool Kit, Auto Mechanics

## **Equipment Condition**

24V heater assembly removed, TM10-3930-660-20.

## **DISASSEMBLY**

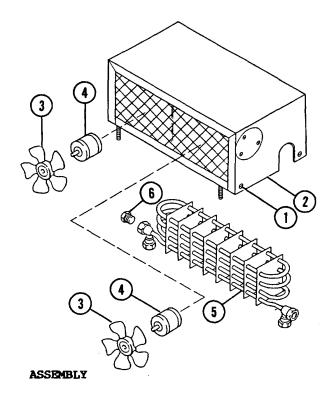
- 1. REMOVE SCREWS (1) AND COVER (2), WITH TWO FAN BLADES (3) AND MOTORS (4).
- 2. REMOVE HEATER CORE (5).
- 3. IF NECESSARY, REMOVE TWO FITTINGS (6).
- REMOVE FAN ASSEMBLIES AND REMOVE
   BLADES (3) FROM MOTORS (4).

## **CLEANING**

- 1. WIPE DUST OR OTHER DEPOSITS FROM BLADES OF FANS (3).
- CLEAN HEATER COIL (4) USING A BRUSH OR LOW PRESSURE COMPRESSED AIR.

## **INSPECTION**

- . CHECK HEATER COIL (5) FOR KINKS OR FOR SIGNS OF LEAKING. REPLACE LEAKING OR DAMAGED HEATER COIL (5).
- 2. CHECK FOR LOOSE OR BENT FAN BLADES (3).
- 3. CHECK MOTORS (4) FOR BAD WIRING CONNECTIONS OR WORN INSULATION



### **ASSEMBLY**

- 1. IF REMOVED, INSTAL FITTINGS (6)
- INSTALL BLADES (3) ON MOTORS (4) AND INSTALL FAN assemblies in cover (2)
- INSTALL HEATER COIL (5).
- 4. INSTALL COVER (2) AND ATTACHING SCREWS (1).

#### **CHAPTER 16**

#### **HYDRAULIC SYSTEMI AINTENANCE**

#### Section I. DESCRIPTION AND DATA

## 16-1. **GENERAL**.

Hydraulic system maintenance procedures not covered in this chapter can be found in TM10-3930-660-20.

## 16-2. PRINCIPLES OF OPERATION.

a. <u>System Description</u>. The hydraulic system of the forklift supplies a controlled flow of filtered hydraulic oil for operation of the boom, carriage, forks, and frame tilt functions. Directions used in the system descriptions are as the reader is sitting in the operator's seat.

Principle components of the hydraulic system and how the components are connected are shown on pages 16-2 and 16-3.

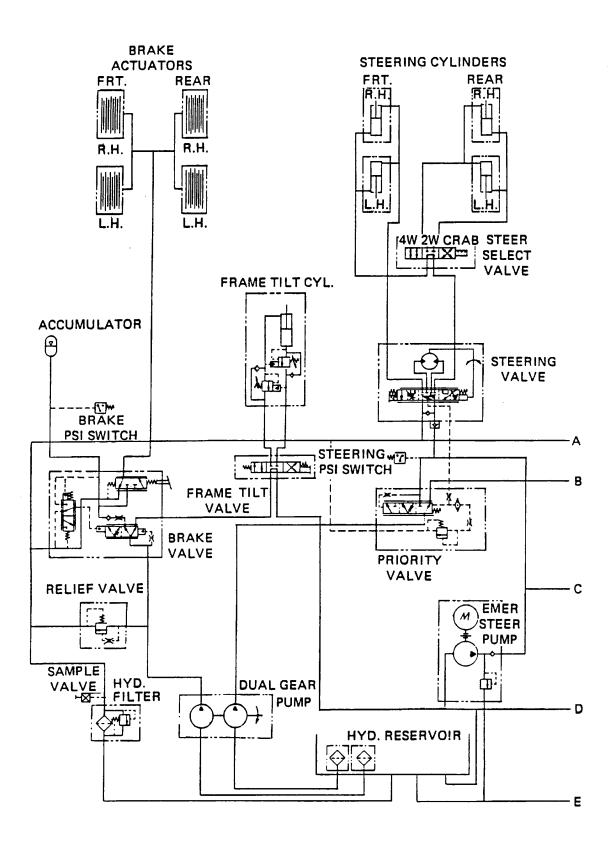
A two section gear pump draws hydraulic oil from the hydraulic reservoir through the suction strainers whenever the engine is operating. The small section (1.48 cu. in.) of the gear pump supplies oil for the brake system, frame tilt function, and charge pressure oil for the axial-piston pump.

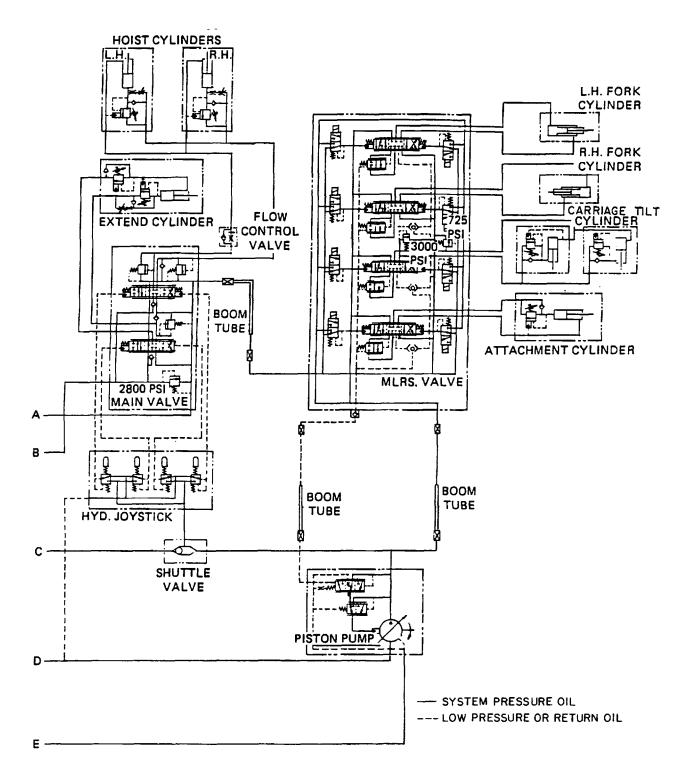
From the small section of the gear pump, oil flows past the relief valve. If system pressure exceeds 1750 psi (12066 kPa), oil pressure unseats the relief valve and allows excess oil to flow through the hydraulic filter back to the reservoir.

Past the relief valve, oil flows through the brake valve, through the frame tilt valve and finally to the axial-piston pump inlet port where the oil is used as charge pressure oil. The remaining oil flows back to the reservoir.

The large section (3.94 cu. in.) of the gear pump supplies oil to the priority valve for the steering system and to the main valve for boom hoist and extend functions. From the main valve, oil flows back through the hydraulic filter and is returned to the reservoir.

Oil flows from the large section of the gear pump to the priority valve. The steering system is first priority, receiving a portion of the total oil flow first. When the steering system is satisfied, oil pressure increases and moves the spool to return the total oil flow to the main valve. A load sensing line from the steering valve to the spring end of the priority spool monitors the pressure in the steering valve, to insure proper oil flow and pressure is provided to the steering valve. When the steering cylinder bottoms, pressure in the steering valve increases. The pilot pressure is relieved through the 2500 psi (17236 kPa) relief valve in the priority valve and all the remaining pump flow is directed to the main valve.





The variable displacement, axial-piston pump supplies oil flow for the MLRS valve which controls fork, carriage, and MLRS attachment functions. The piston pump also supplies oil flow to the hydraulic joystick through the shuttle valve. The shuttle valve closes the port from the emergency steer pump during normal piston pump operation.

The piston pump utilizes specifically designed control valves which is the "brain" of the piston pump and its related hydraulic functions. The valves control delivery of oil flow and pressure in amounts only as required by the function that is operated. Both flow and pressure are tailored to the specific load. All adjustments by the control valves occur in fractions of a second.

When functions of the MLRS valve are idle, the pump is in "stand-by" mode. The load sensing line from the MLRS valve senses no load (zero pressure). Therefore, pump output pressure is controlled only by spring force of the compensator (low pressure) spool spring. The pump will continue its low output until the spring force of the compensator is overcome by the load sensing pressure. Oil from the compensator spool holds the swash plate to near vertical position. The pump is allowed to supply only enough oil flow to meet normal MLRS valve leakage and output pressure is maintained at approximately 400 psi (2758 kPa).

When one or more of the MLRS valves are actuated, the pump goes into "pumping" mode. The load sensing line from the MLRS valve is pressurized by the function experiencing the highest pressure. This pressure is fed back to the compensator spool. The pump continues its output until the load sensing pressure overcomes the compensator spool spring force. Oil from the compensator spool moves the swash plate to an angle that will provide the pump with an output equal to the load sense pressure plus approximately 400 psi (2758 kPa). Therefore the pump will supply only enough flow and pressure to perform the function(s).

The pump is in "maximum high pressure" mode when load sensing line pressure reaches approximately 3000 psi (20685 kPa). The high pressure spool compresses the spring and allows oil to move the swash plate to near vertical position. Oil flow from the compensator spool is stopped and now the pump will supply oil flow to meet circuit leakage and output pressure is maintained at approximately 3000 psi (20685 kPa).

The piston pump is connected to the reservoir so any additional oil required is readily available. Any by-pass oil in the pump can be returned to the reservoir through the drain line.

Return oil from the main valve, steering valve, relief valve of the priority valve, brake valve, and relief valve passes through the hydraulic filter before entering the reservoir. The filter is equipped with a bypass which has a visual indicator showing when bypass is occurring.

b. <u>Frame Tilt System</u>. The frame tilt valve has three operating positions, tilt right, tilt left, and hold. The center position is the hold position.

With the frame tilt valve lever in the hold (center) position, the hydraulic oil is trapped in the cylinder and lines. The cylinder cannot move. Oil flow from the brake valve, which originates from the small section of the gear pump, continues

to the piston pump inlet port and returns to the reservoir through the frame tilt valve.

By moving the frame tilt valve lever forward, the cylinder is extended and tilts the machine to the left. Oil flows to the counterbalance valve for the head end of the cylinder, unseats the ball check, and enters the cylinder. Pressure in the head end begins to increase because oil in the rod end of the cylinder is trapped; the rod end counterbalance valve is closed and ball is seated. The pressure in the head end pilots open the counterbalance valve for the rod end. Oil can now flow from the rod end of the cylinder, allowing the cylinder to extend. Oil from the rod end of the cylinder continues on to the piston pump inlet port and returns to the reservoir.

Moving the frame tilt valve rearward, the cylinder is retracted and tilts the machine to the right. Oil flows to the rod end of the cylinder and pilots open the head end counterbalance valve. Oil flows through the tilt cylinder in the opposite direction of the tilt left function. Oil from the head end is routed to the piston pump inlet port and the reservoir.

All counterbalance valves in hydraulic cylinders also serve as a safety device in case of hose burst or power loss. The counterbalance valves require pressure to pilot them open which will then allow oil to flow. If pressure is removed the counterbalance valve closes and stops the oil from flowing; the cylinder is "locked up".

c. <u>Boom Hoist System</u>. The boom hoist function is controlled by the hydraulic joystick and the main valve. Pilot oil for the hydraulic joystick is routed through the shuttle valve from the piston pump. The pilot return oil is routed to the hydraulic reservoir.

As the hydraulic joystick is moved towards the rear, pilot pressure oil is allowed to flow into the left bottom pilot port of the main valve. The pilot pressure oil pushes the left (boom) spool up, allowing oil to flow through the main valve to the lower work port for the hoist cylinders. Oil flows to the counterbalance valve in the cylinders, unseats the ball check, and enters the head end of the cylinders. The oil pressure pushes the pistons up extending the cylinders, thereby raising the boom. Oil in the rod end of the cylinders is routed through ball check of the flow control, the main valve and to the reservoir through the hydraulic filter.

With the hydraulic joystick in the center position, the pilot oil flow is blocked and each valve in the joystick is connected to the return line to the hydraulic reservoir. The spools of the main control valve are kept in the center position by springs which provides passage for the oil through the valve and back to the reservoir through the hydraulic filter.

As the hydraulic joystick is moved forward, pilot pressure oil is allowed to flow into the left top pilot port of the main valve. The pilot pressure oil pushes the left (boom) spool down, allowing oil to flow through the main valve and orifice of the flow control valve to the rod end of the hoist cylinders. Oil pressure pilots open the counterbalance valve to allow oil in the head end of the hoist cylinders to flow through the main valve and to the reservoir through the hydraulic filter. The orifice controls the rate at which the cylinders are retracted. Boom is lowered at the same rate whether the forks are carrying a load or not.

If working pressure in the boom lift circuit exceeds 2800 psi (19306 kPa), the relief valve in the main valve opens allowing overflow to the return circuit until the pressure decreases below the relief setting. The boom lower circuit relief functions the same way but the port relief valve is set at 950 psi (6206 kPa).

A port relief in the main valve protects the boom hoist circuit from hydraulic shocks or spikes when the counterbalance relief setting is exceeded and main valve spools are closed. When a spike is sensed at the port relief valve, the relief valve is piloted open and allows the excess pressure to be relieved to the return line. As soon as the pressure drops below the port relief valve setting, the valve will close. The port relief valve is set at 3000 psi (20685 kPa).

d. <u>Boom Extend System</u>. The boom extend function is controlled by the hydraulic joystick and the main valve. Pilot oil for the hydraulic joystick is routed through the shuttle valve from the piston pump. The pilot return oil is routed to the hydraulic reservoir.

As the hydraulic joystick is moved to the right, pilot pressure oil is allowed to flow into the bottom center pilot port of the main valve. The pilot pressure oil pushes the center section (extend) spool up, allowing oil to flow through the main valve, out the work port and to the right (head end) port of the boom extend cylinder.

Oil flows to the counterbalance valves of the extend cylinder similar to the frame tilt cylinder and extends the cylinder. From the rod end of the cylinder, oil is routed back to the main valve work port and to the reservoir through the hydraulic filter.

With the hydraulic joystick in the center position, the pilot oil flow is blocked, as in the boom hoist system. Centering springs keep the extend spool of the main control valve in the center position.

As the hydraulic joystick is moved to the left, pilot pressure oil is allowed to flow into the top center pilot port of the main valve. The pilot oil pressure pushes the center section (extend) spool down, allowing oil to flow through the main valve, out the work port and to the left (rod end) port of the boom extend cylinder.

Oil flows to the counterbalance valves of the extend cylinder similar to the frame tilt cylinder and retracts the cylinder. From the head end of the cylinder, oil is routed back to the main valve work port and to the reservoir through the hydraulic filter.

If working pressure in the boom extend circuit exceeds 2800 psi (19306 kPa), the relief valve in the main valve opens allowing overflow to the return circuit until the pressure decreases below the relief setting.

A port relief set at 3000 psi (20685 kPa) protects the boom extend function from hydraulic shocks or spikes, similar to the boom hoist function.

e. <u>MLRS Attachment System.</u> The MLRS attachment function is controlled by the electric joystick and the MLRS control valve. Hydraulic oil flow from the axial piston pump supplies oil pressure and flow for MLRS control valve pilot and function operations. A load sensing line from the MLRS control valve to the piston pump adjusts the pump output. Pilot shuttles in each valve section, allow the pressure of the function with the greatest load to be sensed by the pump. As the load of the MLRS control valve changes, the position of the swash plate angle changes in the piston pump.

When the electric joystick is in the center position, all solenoids of the MLRS control valve are de-energized and centering springs keep the control valve spools in the center (hold) position.

By moving the electric joystick forward, the top left solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the top section towards the right of the machine. The main flow of hydraulic oil goes through the top section, pilots open a load check poppet and allows oil to flow from the work port to the MLRS attachment cylinder. Oil enters the left (rod end) port of the cylinder. The oil pilots open the counterbalance valve on the head end of the cylinder, allowing oil to flow from the head end of the cylinder. The cylinder retracts, lowering the MLRS attachment. Oil from the cylinder enters the work port of the top section of MLRS control valve and is directed to the return circuit where it is sent to the hydraulic reservoir through the hydraulic filter.

The load compensating check valve moves up and down as the load and pump pressure change. If the load increases, the pressure in the work port increases and pushes on the spring side of the load compensating check valve to block oil passage to the work port. At this short instance, the load compensating check valve is operating as a load hold check valve. Increased work port pressure is also sent to the piston pump through the sensing line. The pump output pressure increases sufficiently to maintain the 400 psi (2758 kPa) pressure differential. The increase in pump pressure is now sensed at the smaller end of the load compensating check valve and the valve moves up allowing oil flow to the work port again.

If the electric joystick is moved rearward, the top right solenoid is energized. The oil flow through top section of the MLRS control valve is similar to the retract function but the oil flow to the cylinder is reversed. Oil pressure unseats the ball check in the counterbalance valve on the head end and forces the rod out of the cylinder. The cylinder extends and raises the MLRS attachment.

The maximum pressure in all the circuits of the MLRS control valve is controlled by the maximum discharge of the pump which is 3000 psi (20685 kPa).

f. <u>Carriage Tilt System</u>. The carriage tilt function is also controlled by the electric joystick and the MLRS control valve. Hydraulic oil from the piston pump flows through the control valve the same as for the above MLRS attachment system.

Move the electric joystick to the left and the second from the top right solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the second section towards the left of the machine. Oil flows through the second section, pilots open a load compensating

check valve and flows from the work port to the rod end ports of both carriage tilt cylinders. The load compensating check valve operation is the same as described in the MLRS attachment system. Oil pressure unseats the ball check in the counterbalance valve on the rod end and pushes the cylinder piston into each cylinder. Oil in the head end of the cylinder flows from the head end port and back to the MLRS control valve. The cylinder retracts which raises the fork tips. Oil from the tilt cylinders is directed to the MLRS control valve return circuit and back to the hydraulic reservoir through the hydraulic filter.

If the electric joystick is moved to the right, the second from the top left solenoid is energized. The oil flow through the second section is similar to the fork tips raise function but the oil flow to the tilt cylinders is reversed. Oil flows to the head end of the tilt cylinders and pilots open the counterbalance on the rod end of the cylinders. Oil is allowed to flow from the rod end and back to the return circuit of the MLRS valve. The cylinders extend and lower the fork tips.

A port relief valve set at 3000 psi (20685 kPa) is connected to the rod end of the tilt cylinders. The relief valve protects the hydraulic lines from bursting when shocks or spikes are encountered on the rod side of the cylinder.

The fork tips lower port relief valve is connected to the head end of the cylinders. The relief valve is set at 725 psi (5064 kPa) to limit any external upward force on the forks.

g. <u>Fork Sideshift System</u>. The fork sideshift function, as with the previous two functions, is controlled by the electric joystick and the MLRS control valve. Hydraulic oil from the piston pump flows through the control valve as in the other two MLRS systems. The third section of the MLRS valve controls the left fork (right cylinder) and the bottom (fourth) section controls the right fork (left cylinder).

Push the button on top of the electric joystick and move the joystick to the left and the third from the top right solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the third section towards the left of the machine. System oil flows through the third section, pilots open a load compensating check valve and allows oil to flow from the work port to the head end port of right cylinder which moves the left fork to the left. Oil in the rod end of the cylinder flows back to the return circuit of the MLRS control valve.

If the button is held and the electric joystick is moved to the right, the third from the top left solenoid is energized. The oil flow through the third section of the MLRS valve is similar to the above left fork motion but the flow to the cylinder is reversed. Oil pressure is sent to the rod end port of the right cylinder which retracts the cylinder and moves the left fork to the right.

The above description of hydraulic function for the left fork can also be applied to the right fork. The button is held down while the electric joystick is moved front to rear to control the right fork position.

While holding button down on top of the electric joystick and moving the joystick diagonally from center will energize two solenoids at the same time. These four diagonal positions can move the forks apart, together, both right, or both left depending on which combination of solenoids is used.

# Section II. HYDRAULIC SYSTEM MAINTENANCE PROCEDURES

# HYDRAULIC SYSTEM MAINTENANCE TASK SUMMARY

TASK PARA.	PROCEDURES	PAGE NO.	
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16-4	Main Control Valve Assembly - Repair	16-19	
16-5	MLRS Attachment Control Valve - Repair	16-24	
16-6	Priority Valve - Repair	16-30	
16-7	Frame Tilt/Brakes Relief Valve - Repair	16-31	
16-8	Frame Tilt Valve - Repair	16-34	
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16-13	Boom Pivot Pin - Replace	16-89	
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16-15	Extend and Retract Chains - Replace	16-94	
16-16	Boom Extend Cylinder - Replace/Repair	16-98	
16-17	Fork Sideshift Cylinders - Repair	16-107	
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16-21	Piston Pump - Repair	16-128	

### 16-3. TANDEM GEAR PUMP - REPAIR

# This task covers:

a. Removal

b. Disassembly

c. Inspection

d. Reassembly

e. Pre-Load Check of Bearing

f. Installation

### **INITIAL SETUP:**

Tools

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

Fabricated Tools for Repair:

Fabricated Tool - Seal Removal Tool (App. C, Fig. C-I)

Fabricated Tool - Drive Gear Installation Tool (App. C, Fig. C-2)

**Equipment Condition** 

Tandem gear pump removed, TM10-3930-660-20.

Materials/Parts

Grease (App. B, Item 11)

Hydraulic Oil (App. B, Item 35)

Lint-Free Rag (App. B, Item 38) Loctite 9242 (App. B, Item 41)

Permatex Form-A-Gasket No. 3 Sealant

(App. B, Item 47)

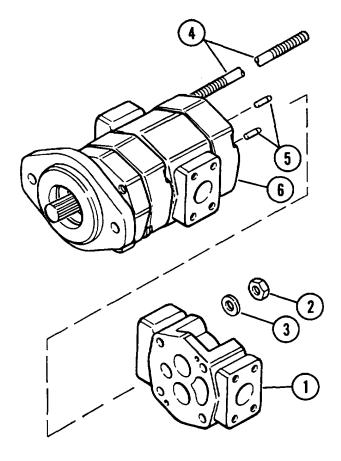
Seals (9, 13, 16, 22, 27, 29, 31)

### **DISASSEMBLY**

## **CAUTION**

Prying notches are provided between the pump sections. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and damaged parts.

- PLACE PUMP IN A VISE WITH DRIVE SHAFT POINTING DOWN. MARK ALL SECTIONS TO BE USED FOR ALIGNMENT AT ASSEMBLY.
- 2. REMOVE THE COVER (1).
  - a. Remove four nuts (2) and washers (3) from studs (4).



# 16-3. TANDIEM GEAR PUMP - REPAIR (Cont'd)

b. Remove cover (1).

set.

# **NOTE**

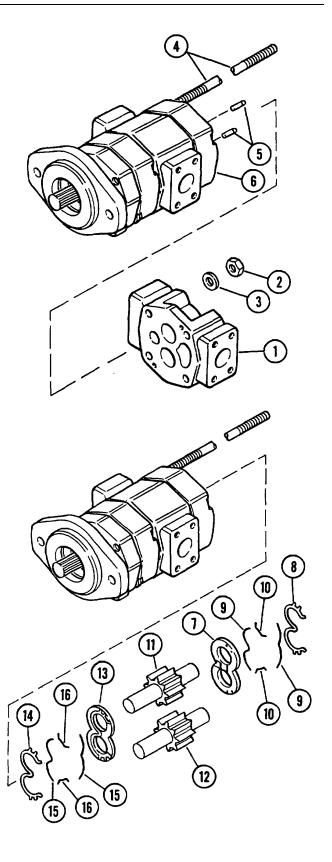
Dowel pins (5) will remain in cover (1)or housing (6).

- 3. REMOVE THE GEAR HOUSING (6) AND OTHER PARTS (7-19).
  - a. Remove thrust plate (7). Remove and discard seal (8), two seals (9), and two seals (10).

# **CAUTION**

Gears are closely machined, therefore they must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals.

- b. Carefully remove drive gear (11) and driven gear (12). Keep these parts together as a matched
- c. Remove thrust plate (13). Remove and discard seal (14), two seals (15), and two seals (16).

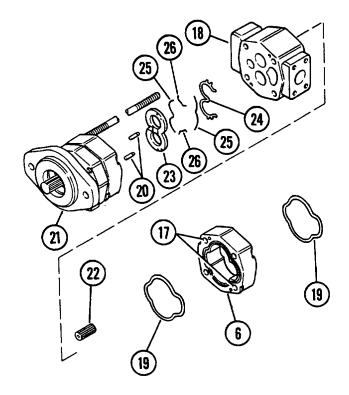


# 16-3. TANDEM GEAR PUKP - REPAIR (Cont'd)

- d. Remove gear housing (6). Dowel pins (17) will remain in gear housing (6) or bearing carrier (18). Do not remove dowel pins (17).
- e. Remove and discard two seals (19) from gear housing (6).
- 4. REMOVE BEARING CARRIER (18) AND OTHER PARTS (22-28).
  - a. Pry off bearing carrier (18). Dowel pins (20) will remain in either bearing carrier (18) or gear housing (21). Do not remove dowel

pins (20).

- b. Remove connecting shaft (22).
- c. Remove thrust plate (23). Remove and discard seal (24), two seals (25), and two seals (26).

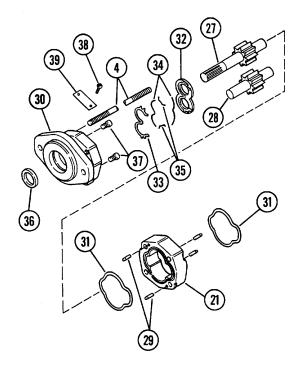


# 16-3. TANDEM GEAR PUMP - REPAIR (Cont'd)

# **CAUTION**

Gears are closely machined, therefore they must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals.

- d. Remove drive gear (27) and driven gear (28).
- 5. REMOVE GEAR HOUSING (21) AND OTHER PARTS (29-35).
  - a. Pry off gear housing (21). Dowel pins (29) will remain in either gear housing (21) or end cover (30). Do not remove dowel pins (29).
  - b. Remove and discard two seals (31)from gear housing (21).
  - c. Remove thrust plate (32). Remove and discard seal (33), two seals (34), and two seals (35).
- 6. REMOVE PARTS (4 and 36-39) FROM END COVER (30).



# **CAUTION**

Do not grip on or near any machined surfaces during disassembly or assembly. Failure to follow this precaution will cause part damage.

a. Place end cover (30) in a vise with mounting side face down.

# 16-3. TANDEM GEAR PUIP - REPAIR (Cont'd)

- b. Insert fabricated seal removal tool (App. B, Fig. C-1) into notch between double lip seal (36) and end cover (30). Tap seal out and discard.
- c. Use a screwdriver to remove two plugs (37).
- d. Remove two screws (38) and plate (39).
- e. Remove four studs (4).

### **CLEANING**

See Cleaning Instructions, para. 2-10.

# **INSPECTION**

- INSPECT GEAR HOUSINGS (6 AND 21). REPLACE GEAR HOUSINGS IF WEAR EXCEEDS 0.007 INCH CUTOUT.
  - a. Place a straightedge across the bore. If a 0.007 inch feeler gauge can be slipped under the straightedge in cutout area, replace gear housing.
  - b. If cutouts are 0.007 inch or less, gear housing is in good condition and may be used.
- 2. INSPECT THRUST PLATES (7, 13, 23 AND 32) FOR WEAR, SCORING, PITTING, OR ERODING.
  - a. Erosion indicates oil contamination. Pitted thrust plates indicates cavitation or oil aeration. Discolored thrust plates indicate overheating, probably insufficient oil.
  - b. Replace thrust plates if wear exceeds 0.002 inch.
- 3. SEE INSPECTION INSTRUCTIONS, PARA. 2-11.

# 16-3. TANDEM GEAR PUMP - REPAIR (Cont'd)

### **ASSEMBLY**

## **CAUTION**

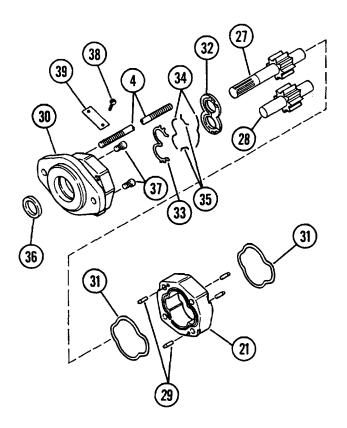
Do not grip on or near any machined surfaces during disassembly or assembly. Failure to follow this precaution will cause part damage.

## **NOTE**

Wipe all sealing surfaces clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. INSTALL PARTS (36-39) IN END COVER (30).
  - a. Secure plate (39) with two screws (38).
  - b. Place end cover (30) in a vise with mounting face down.
  - c. If removal of two plugs (37) was necessary, apply on threads. Install them in end cover (30). Stake each plug with a punch at both ends of screwdriver slot and around edges. Peen edge of hole 1/32 to 1/16 inch with a 1-1/2 inch steel diameter ball.
  - d. Apply Permatex Aviation

Form-A-Gasket No. 3 sealant on lip seal (36). With metal side of seal up, use an arbor press and a bar (1-3/4 inch diameter by 2 inch long bar), press seal (36) into end cover (30). Press seal flush with recess. Wipe off excess sealant.



# 16-3. TANDEI GEAR PUMP - REPAIR (Cont'd)

- 2. INSTALL GEAR HOUSING (21) AND OTHER PARTS (27-35).
  - a. Apply grease on two new seals (31). Install seals (31) into grooves on gear housing (21).

## **CAUTION**

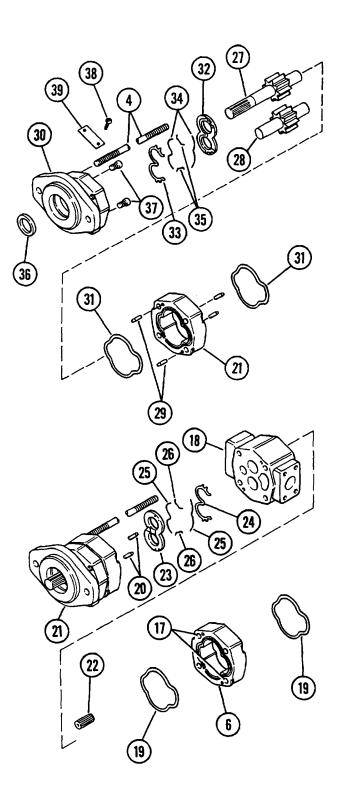
If parts are difficult to fit during assembly, tap gently with a soft hammer. Use care to prevent part damage.

- b. Ensure that dowel pins (29) are in place. Install gear housing (21) onto end cover (30). Gently tap gear housing (21) tight against end cover (30). Use care to prevent damage to seals (31).
- c. Install new seals (33), (34), and (35) into grooves in thrust plate (32) with flat side of seal (33) facing away from thrust plate.
- d. Slip thrust plate (32) through gear housing (21) into end cover (30). The seal (33) should face away from end cover (30). The relief groove in thrust plate (32) should face pump outlet side.
- e. Slide driven gear (28) through gear housing (21) into end cover (30).
- f. Apply grease on fabricated drive gear installation tool (App. B, Fig. C-2). Place shaft of greased drive gear (27) inside tool. Slide both through end cover (30) with a twisting motion. The integral gears should rest against thrust plate (32).

  Remove drive gear installation tool. Apply oil on

Remove drive gear installation tool. Apply oil on gears (27 and 28)

- 3. INSTALL BEARING CARRIER (18) AND OTHER PARTS (22-28).
  - a. Install new seals (24), (25), and (26) in thrust plate (23) with flat side of seal (24) facing away from thrust plate.
  - b. Slip thrust plate (23) over gears (27 and 28) and into gear housing bore (21). The flat side of seal should be facing outlet side.



# 16-3. TANDEM GEAR PUMP - REPAIR (Cont'd)

# **CAUTION**

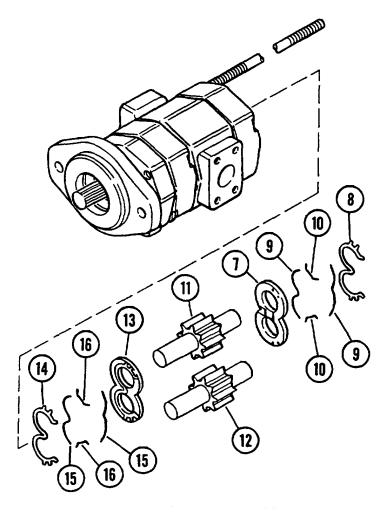
If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- c. Ensure that dowel pins (20) are in place. Install bearing carrier (18) onto gear housing (21). Align dowel holes over dowel pins (20). Use a soft hammer to tap parts together.
- d. Install connecting shaft (22) in spline of drive gear (27).
- 4. INSTALL GEAR HOUSING (6) AND OTHER PARTS (7-16, 19).
  - a. Apply grease on two new seals (19). Install seals (19) into grooves on gear housing (6).

## **CAUTION**

If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- b. Ensure that dowel pins (17) are in place. Install gear housing (6) onto bearing carrier (18). Align dowel holes over dowel pins (17). Use a soft hammer to tap parts together. Use care to prevent damage to seals (31).
- c. Install new seals (14), (15), and (16) into grooves in thrust plate (13) with flat side of seal (14) facing away from thrust plate.
- d. Install drive gear (11) driven gear (12) into bearing carrier (15). Ensure that gears are in contact with thrust plate (13) face.
- e. Install new seals (8), (9), and (10) into grooves in thrust plate (7) with flat side of seal facing away from thrust plate.
- f. Install thrust plate (7) with seals over gears (11 and 12). The flat side of seal (8) should be facing up with relief groove facing outlet side.



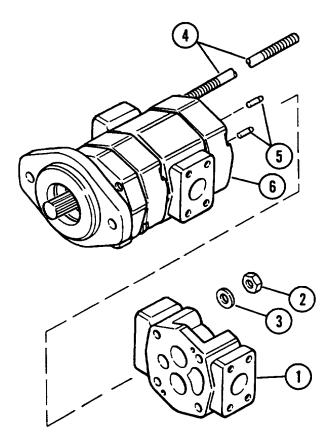
# 16-3. TANDEM GEAR PUMP - REPAIR (Cont'd)

5. INSTALL COVER (1) WITH OTHER PARTS (2-4 AND 6).

# **CAUTION**

If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- a. Ensure that dowel pins (5) are in place. Install cover (1) onto gear housing (6). Align dowel holes over dowel pins (5). Use a soft hammer to tap parts together. Use care to prevent damage to seals (19).
- b. Install four studs (4) through all housings and into end cover (30). Studs (4) should be flush with shaft end of end cover (30).
- c. Install four washers (3) and nuts (2). Finger tighten alternately.
- Rotate pump shaft to ensure there is no binding. After nuts (2) are tight and there is no binding, torque to 200 ft. lbs.
- 6. INSTALL TANDEM PUMP GEAR, TM10-3930-660-20.



# 16-4. MAIN CONTROL VALVE ASSEMBLY - REPAIR

### This task covers:

a. Removal

b. Disassembly

c. Inspection

d. Reassembly

e. Pre-Load Check of Bearing

f. Installation

# **INITIAL SETUP:**

## Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

Boom cylinder flow control valve removed, TM10-3930-660-20. Main control valve assembly removed, TM10-3930-660-20.

## Materials/Parts

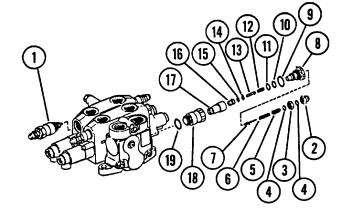
Hydraulic Oil (App. B, Item 35) Lint-Free Rags (App. B, Item 38) O-rings (4, 9, 11, 14, 19, 23, 28, 30, 33, 38, 46, 55, 65, 66)

### **DISASSEMBLY**

### NOTE

Do not remove relief valves unless they are being replaced.

- 1. REMOVE AND DISASSEMBLE TWO MAIN RELIEF VALVES (1) IF NECESSARY.
  - a. Remove nuts (2 and 3). Remove and discard two seals (4) from nuts (2 and 3).
  - b. Remove adjusting screw (5), spring (6) and poppet (7).
  - Remove plug (8), O-ring (9), back-up ring (10) and O-ring (11). Discard O-rings (9 and 11).
  - d. Remove spring (12), piston (13), O-ring (14), back-up ring (15) and poppet (16 and 17). Discard O-ring (14).



# 16-4. MAIN CONTROL VALVE ASSEMBLY - REPAIR (Cont'd)

e. Remove body (18) and O-ring (19). Discard O-ring (19).

# **NOTE**

Do not remove relief valves unless they are being replaced.

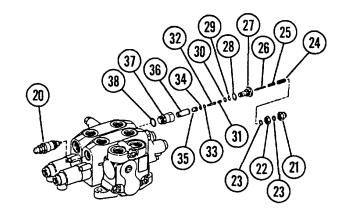
- 2. REMOVE AND DISASSEMBLE TWO RELIEF VALVES (20) IF NECESSARY.
  - a. Remove nuts (21 and 22). Remove and discard two seals (23) from nuts (21 and 22).
  - b. Remove adjusting screw (24), spring (25) and poppet (26).
  - c. Remove plug (27), O-ring (28), back-up ring (29) and O-ring (30). Discard O-rings (28 and 30).
  - d. Remove spring (31), piston (32), O-ring (33), back-up ring (34) and poppets (35 and 36). Discard O-ring (33).
  - e. Remove body (37) and O-ring (38). Discard O-ring (38).
- 3. DISASSEMBLE VALVE (39-68).
  - a. Mark housing sections of valve. These marks will be used for assembly.
  - b. Remove two nuts (39), one nut (40) and outlet section (41).

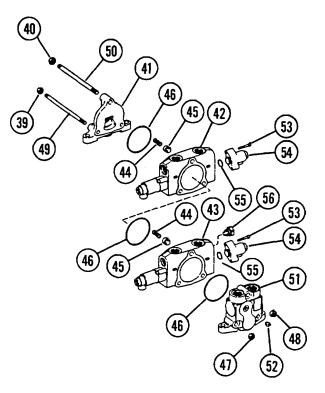
#### **NOTE**

Be careful not to loose springs (44) and poppets (45) when removing housing sections.

- c. Remove housing sections (42 and 43).
- d. Remove two springs (44) and two poppets (45).

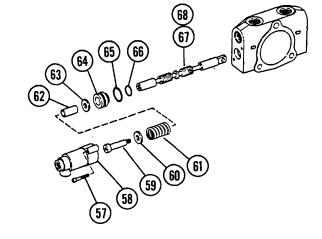
16-20





# 16-4. MAIN CONTROL VALVE ASSEMIBLY - REPAIR (Cont'd)

- e. Remove and discard three O-rings (46).
- f. Remove two nuts (47), one nut (48), two tie rods (49), one tie rod (50) and inlet housing (51).
- g. Remove plug (52) if necessary.
- h. Remove two cap screws (53) from two spool caps (54).
- i. Remove and discard two O-rings (55).
- j. Remove plug assembly (56) if necessary.
- k. Remove two cap screws (57) from two spool caps (58).
- I. Remove two socket head shoulder screws (59), flatwashers (60), springs (61), spacers (62) and flatwashers (63).



- m. Remove two retainers (64) and O-rings (65 and 66). Discard O-rings (65 and 66).
- n. Remove two spools (67 and 68).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

# **ASSEMBLY**

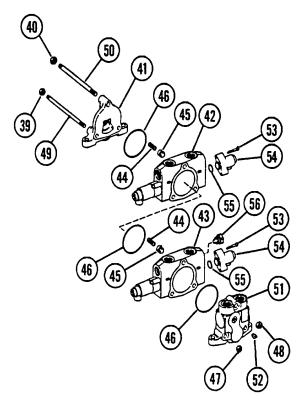
#### NOTE

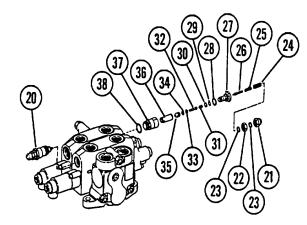
Wipe all sealing surfaces on valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

16-21

# 16-4. MAIN CONTROL VALVE ASSEMBLY - REPAIR (Cont'd)

- 1. ASSEMBLE VALVE (39-68).
  - a. Install two spools (67 and 68).
  - b. Install new O-rings (65 and 66) on two retainers (64).
  - c. Install two retainers (64), flatwashers (63), spacers (62), springs (61), flatwashers (60) and socket head shoulder screws (59).
  - d. Install two spool caps (58) and cap screws (57).
  - e. If removal of plug assembly (56) was necessary, install it in housing section (43).
  - f. Install two new O-rings (55) on spool caps (54).
  - g. Install two spool caps (54) and cap screws (53).
  - h. If removal of plug (52) was necessary, install it in inlet housing (51).
  - i. Install three new O-rings (46) in housing sections (42, 43 and 51).
  - j. Install two poppets (45) and springs (44).
  - Use match lines on housing sections (41, 42, 43 and 51) and install them in proper order on tie rods (49 and 50).
  - I. Install two nuts (47), one nut (48), two nuts (39) and one nut (40) on tie rods (49 and 50).
  - m. Torque nuts (40 and 48) to 74 ft. lbs. Torque nuts (39 and 47) to 48 ft. lbs.

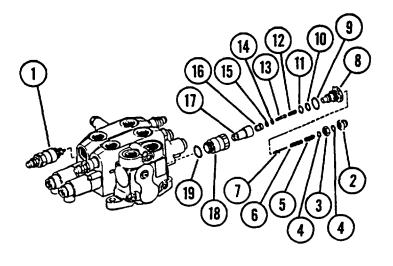




# 16-4. MAIN CONTROL VALVE ASSEMBLY - REPAIR (Cont'd)

# 2. IF REMOVAL WAS NECESSARY, ASSEMBLE AND INSTALL TWO RELIEF VALVES (20).

- a. Install new O-ring (38) on body (37).
- b. Install new O-ring (33) on poppet (35). Install back-up ring (34).
- c. Install poppet (36), poppet (35), piston (32) and spring (31) into body (37).
- d. Install new O-rings (28 and 30) onto plug (27).
- e. Install back-up ring (29) onto plug (27). Install plug assembly (27) into body (37).
- f. Install poppet (26), spring (25) and adjusting screw (24).
- g. Install one new O-ring (23) into each nut (21 and 22).
- h. Install nuts (21 and 22).
- i. Install two relief valve assemblies (20).
- 3. IF REMOVAL WAS NECESSARY, ASSEMBLE AND INSTALL TWO RELIEF VALVES (1).
  - a. Install new O-ring (19) on body (18).
  - b. Install new O-ring (14) on poppet (13). Install back-up ring (15).
  - c. Install poppet (17), poppet (16), piston (13), and spring (12) into body (18).
  - d. Install new O-rings (9 and 11) onto plug (8).
  - e. Install back-up ring (10) onto plug (8). Install plug assembly (8) into body (18).



- f. Install poppet (7), spring (6) and adjusting screw (5).
- g. Install one new O-ring (4) into each nut (2 and 3).
- h. Install nuts (2 and 3).
- i. Install two relief valve assemblies (1).
- 4. INSTALL MAIN CONTROL VALVE ASSEMBLY, TM10-3930-660-20.
- 5. INSTALL BOOM CYLINDER FLOW CONTROL VALVE, TM10-3930-660-20.

# 16-5. MLRS ATTACHMENT CONTROL VALVE - REPAIR

This task covers:

a. Removal

b. Disassembly

c. Inspectiond. Reassembly

e. Pre-Load Check of Bearing

f. Installation

### **INITIAL SETUP:**

Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common t2 Less Power

Equipment Condition MLRS attachment control valve removed, TM10-3930-660-20.

Materials/Parts

Hydraulic Oil (App. B, Item 35) Lint-Free Rags (App. B, Item 38) Lockwashers (49) O-rings (3, 4, 7, 14, 17, 22, 24, 27, 42, 43, 51, 52, 60, 62)

# **DISASSEMBLY**

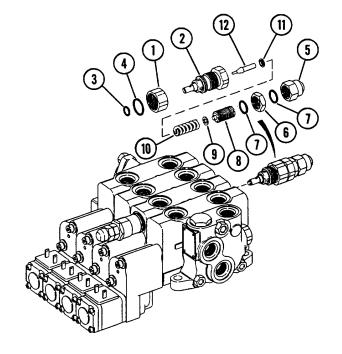
#### **NOTE**

Do not remove relief valves unless they are being disassembled.

- 1. REMOVE AND DISASSEMBLE RELIEF VALVE PARTS (1-12).
  - Loosen nut (1) on body (2) and remove entire relief valve (parts 1-13) as an assembly. Remove and discard O-rings (3) and (4).
  - b. If necessary, remove nut (1).
  - c. If necessary, remove nuts (5) and (6). Remove and discard two O-rings (7).

#### **NOTE**

Do not remove relief valves unless they are being disassembled.



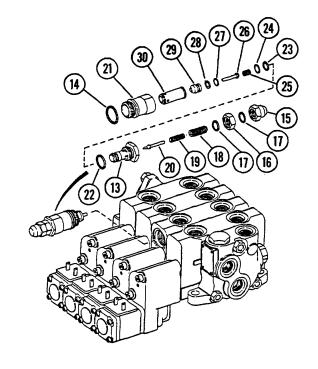
# 16-5. MLRS ATTACOKENT COVAROL VALVE - REPAIR (Cont'd)

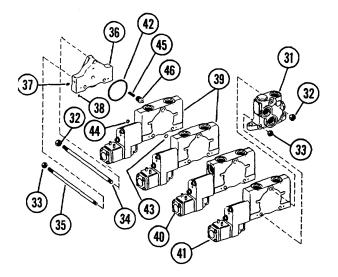
- 2. REMOVE AND DISASSEMBLE RELIEF VALVE PARTS (13-30) IF NECESSARY.
  - Loosen plug (13) and remove entire relief valve (parts 13-30) as an assembly. Remove and discard O-ring (14).
  - b. Remove nuts (15 and 16). Remove and discard two seals (17) from nuts (15 and 16).
  - c. Remove adjusting screw (18), spring (19) and poppet (20).
  - d. Remove plug (13) from body (21).
     Remove O-ring (22), back-up ring (23) and O-ring (24).
     Discard O-rings (22 and 24).
  - e. Remove spring (25), piston (26), O-ring (27), back-up ring (28) and poppets (29 and 30). Discard O-ring (27).
- 3. DISASSEMBLE VALVE PARTS (31-62).
  - a. Mark housing sections. These marks will be used for assembly.
  - b. Place valve so it is resting on housing inlet (31).

#### NOTE

Use care when removing outlet and housing sections. Do not lose poppets and springs that may eject from housing sections.

- c. Remove nuts (32 and 33), tie rod (34), two tie rods (35), and outlet housing (36).
- d. Remove plugs (37 and 38) if necessary.
- e. Separate housings (39, 40, and 41) and inlet housing (31).





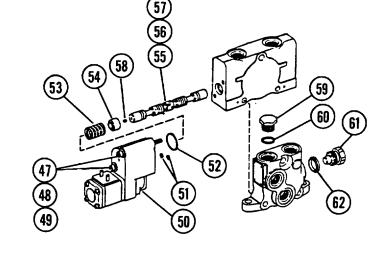
# 16-5. MLRS ATTACHMENT CONTROL VALVE - REPAIR (Cont'd)

f. Remove and discard one large O-ring (42) and two small O-rings (43) from each face of housing section.

#### **NOTE**

Valve section (39) closest to outlet housing (36) has no shuttle plate (44).

- g. Remove three shuttle plates (44), four springs (45) and four compensator pistons (46).
- h. Remove two bolts (47), flat- washers (48) and lockwashers (49) from each Electric Hydraulic Proportioning (EHP) assembly (50). Remove eight EHP assemblies (50). Discard lockwashers (49).
- Remove and discard two small O-rings (51) and one large O-ring (52) from each EHP assembly (50).



- j. Remove spring (53) and spring seat54) from each housing section.
- k. Remove spools (55 and 56) and two spools (57) from housing sections.
- I. Remove plug (58) from each spool.
- m. Remove plug (59) and O-ring (60) if necessary. Discard O-ring (60).
- n. Remove plug (61) and O-ring (62)if necessary. Discard O-ring (62).

# **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

# 16-5. MLRS ATTACBHENT CONTROL VALVE - REPAIR (Cont'd)

#### **ASSEMBLY**

#### **NOTE**

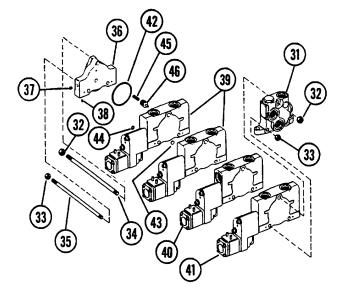
Wipe all sealing surfaces on valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. ASSEMBLE VALVE PARTS (31-62).
  - a. If removal of O-ring (62) and plug (61) was necessary, install plug (61) with new O-ring (62).
  - b. If removal of O-ring (60) and plug (59) was necessary, install plug (59) with new O-ring (60).
  - c. Install plug (58) into each spool (55, 56 and 57).
  - d. Install spools (55 and 56) and two spools (57).
  - e. Install spring seat (54) and spring (53) in each housing section.
  - f. Install two new small O-rings (51) and one new large O-ring (52) to each EHP assembly (50).
  - g. Install eight Electric Hydraulic Proportioning (EHP) assemblies (50) with new lockwashers (49), flatwashers (48) and two bolts (47).

### NOTE

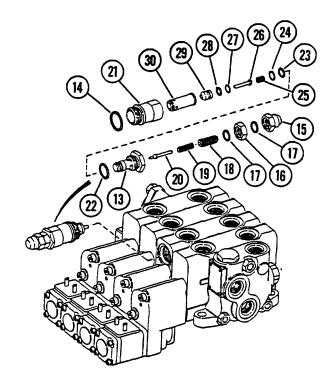
Valve section (39) closest to outlet housing (36) has no shuttle plate (44).

- h. Install four pistons (46), four springs (45) and three shuttle plates (44).
- i. Install one new large O-ring (42) and two new small O-rings (43) in each face of housing sections.



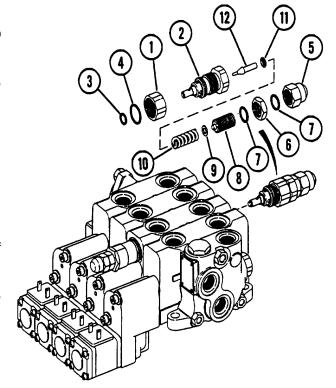
# 16-5. MLRS ATTACHMENT CONTROL VALVE - REPAIR (Cont'd)

- If removal of plugs (37 and 38) was necessary, install them.
- k. Use match lines on housing sections (39, 40 and 41), inlet housing (31) and outlet housing (36) and assemble them in proper order on tie rod (34) and two tie rods (35). Install nuts (32 and 33).
- I. Torque four nuts (33) to 14 ft. lbs. Torque two nuts (32) to 33 ft. lbs.
- 2. IF REMOVAL WAS NECESSARY, ASSEMBLE AND INSTALL RELIEF VALVE PARTS (13-30).
  - a. Install new O-ring (27) on poppet (29).Install back-up ring (28).
  - b. Install poppet (30), poppet (29), piston (26), and spring (25) into body (21).
  - c. Install new O-rings (22 and 24) onto plug (13).
  - d. Install back-up ring (23) onto plug (13). Install plug assembly (13) into body (21).
  - e. Install poppet (20), spring (19) and adjusting screw (18).
  - f. Install one new O-ring (17) into each nut (15 and 16).
  - g. Install nuts (15 and 16).
  - h. Install relief valve parts (13-30) as an assembly. Torque relief valve to between 30 and 50 ft. lbs. at plug (13).



# 16-5. MLRS ATTACHMENT CONTROL VALVE - REPAIR (Cont'd)

- 3. IF REMOVAL WAS NECESSARY, ASSEMBLE AND INSTALL RELIEF VALVE (1-12).
  - a. Install poppet (12), spring retainer (11), spring (10), shim (9) and adjusting screw (8) into body (2).
  - b. Install one new O-ring (7) in each nut (5 and 6).
  - c. Install nuts (5 and 6).
  - d. Install nut (1) onto body (2).
  - e. Install new O-rings (3 and 4) on nut (1).
  - f. Install relief valve (1-12) as an assembly. Torque relief valve between 22 and 28 ft. lbs.
- 4. INSTALL MLRS ATTAGCMENT CONTROL VALVE, TM10-3930-660-20.



16-29

#### 16-6. PRIORITY VALVE - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# **INITIAL SETUP:**

Tools

Tool Kit, Automotive Mechanics

**Equipment Condition** 

Priority valve removed, TM10-3930-660-20.

#### Materials/Parts

Hydraulic Oil (App.B, Item 35) Lint-Free Rags (App.B, Item 38) O-rings (3, 5, 7)

#### **DISASSEMBLY**

- REMOVE RELIEF VALVE CARTRIDGE (1)FROM HOUSING (2).
- 2. REMOVE AND DISCARD O-RING (3).
- 3. REMOVE PLUG (4).REMOVE AND DISCARDORING (5).
- 4. REMOVE PLUG (6).REMOVE AND DISCARDORING (7).
- 5. REMOVE SPRING (8) AND SPOOL (9).

#### **CLEANING**

See Cleaning Instructions, para.2-10.

#### **INSPECTION**

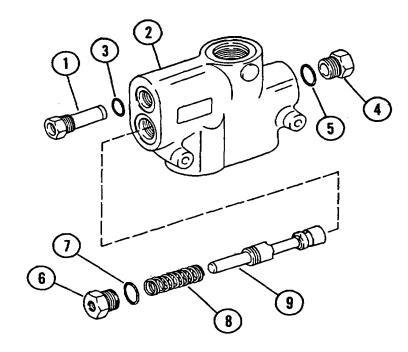
See Inspection Instructions, para.2-11.

# **ASSEMBLY**

#### **NOTE**

Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

1. INSTALL NEW O-RING (5) ON PLUG (4). INSTALL PLUG (4) IN HOUSING (2). FINGER TIGHTEN PLUG (4).



- 2. INSTALL SPOOL (9) AND SPRING (8).
- 3. INSTALL NEW O-RING (7) ON PLUG (6). INSTALL PLUG (6) IN HOUSING (2). FINGER TIGHTEN PLUG(6).
- 4. INSTALL NEW O-RING (3) ON RELIEF VALVE CARTRIDGE (1).INSTALL RELIEF VALVE CARTRIDGE (1) IN HOUSING (2).
- 5. INSTALL PRIORITY VALVE, TM10-3930-660-20.

#### 16-7. FRAME TILT/BRAKES RELIEF VALVE - REPAIR

#### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

#### **INITIAL SETUP:**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

# **Equipment Condition**

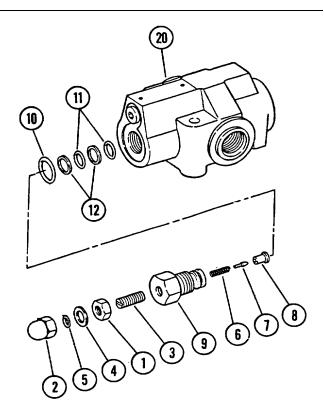
Frame tilt/brakes relief valve remove TM10-3930-660-20.

# Materials/Parts

Hydraulic Oil (App.B, Item 35) Lint-Free Rags (App.B, Item 38) O-rings (5, 10, 11, 15)

# **DISASSEMBLY**

- 1. REMOVE AND DISASSEMBLE RELIEF VALVE ASSEMBLY (1-19) FROM BODY (20).
  - a. Use a wrench to hold jam nut (1) in place and remove acorn nut (2).
  - b. Hold setscrew (3) in place and loosen jam nut (1).
  - c. Record number of turns required to remove setscrew (3).
  - d. Remove two sealing washers (4) and O-rings (5). Discard O-rings (5).
  - e. Remove spring (6), plunger (7) and seat (8) from cap (9).
  - Remove and discard O-ring (10) and two O-rings (11).Back-up rings (12) are not removed.
  - g. Remove spring (13), poppet assembly (14) and O-ring (15). Discard O-ring (15).



# 16-7. FRAME TILT/BRAKES RELIEF VALVE - REPAIR (Cont'd)

- h. Remove retainer (16), screw (17) and poppet (18) if necessary.
- i. Do not remove seat (19) from body (20).
- REMOVE PLUGS (21 AND 22) IF NECESSARY.
- 3. REMOVE TWO SCREWS (23) AND NAMEPLATE (24) IF NECESSARY.

#### **CLEANING**

See Cleaning Instructions, para.2-10.

# **INSPECTION**

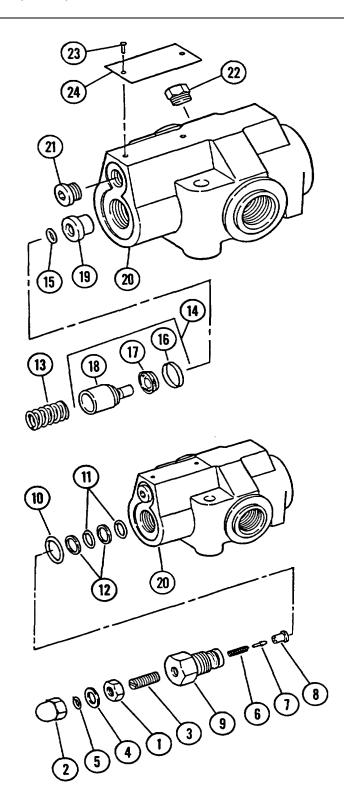
See Inspection Instructions, para 2-11.

#### **ASSEMBLY**

#### **NOTE**

Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- IF REMOVAL WAS NECESSARY, INSTALL NAMEPLATE (24) AND TWO SCREWS (23).
- 2. IF REMOVAL WAS NECESSARY, INSTALL PLUGS (21 AND 22).
- 3. ASSEMBLE AND INSTALL RELIEF VALVE (1-19) INTO BODY (20).
  - a. Install new O-ring (15) in seat (19).
  - b. If removal was necessary, install screw (17) and retainer (16) on poppet (18).
  - c. Install poppet assembly (14) and spring (13) into body (20).
  - d. Install two new O-rings (11) and O-ring (10) on cap (9). Ensure that back-up rings (12) are correctly positioned.



# 16-7. FRAME TILT/BRAKES RELIEF VALVE - REPAIR (Cont'd)

- e. Install spring (6), plunger (7) and seat (8) in cap (9).
- f. Install cap (9). Ensure that spring (13) is positioned over seat (8).
- g. Install setscrew (3) using the same number of turns as was noted during removal.
- h. Install jam nut (1) and tighten to hold setting.
- i. Install two new O-rings (5) with sealing washers (4).
- j. Hold jam nut (1) in position and install acorn nut (2).
- 4. INSTALL FRAME TILT/BRAKES RELIEF VALVE, TM10-3930-660-20.

#### 16-8. FRAME TILT VALVE - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

#### **INITIAL SETUP:**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and Attachment Hoist; Spanner Wrench, Fork Sideshift Cylinder - Outer Gland; Spanner Wrench, Fork Sideshift Cylinder - Outer Piston; Spanner Wrench, Boom Lift Cylinder and Boom Extend Cylinder

#### **Equipment Condition**

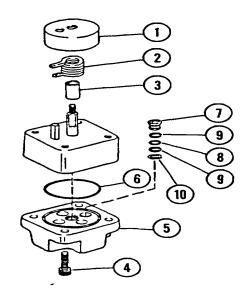
Frame tilt valve removed, TM10-3930-660-20.

# Materials/Parts

Hydraulic Oil (App.B, Item 35) Lint-Free Rags (App.B, Item 38) O-rings (6, 8, 17)

#### **DISASSEMBLY**

- 1. REMOVE HUB (1).REMOVE SPRING (2). REMOVE BUSHING (3).
- 2. DISASSEMBLE COMPONENTS (4-20).
  - a. Remove four socket head screws (4), body (5) and O-ring (6).
  - b. Remove four seals (7), four O-rings (8), eight back-up rings (9) and four seal springs (10). Discard O-rings (8).
  - c. Remove shaft washer (11) and disk assembly (12) from shaft (13).
  - d. Remove bearing race (14), bearing (15) and stop plate (16).



# 16-8. FRAME TILT VALVE - REPAIR (Cont'd)

- e. Remove O-ring (17) and back-up ring (18). Discard O-ring (17).
- f. Do not remove stop pin (19) from cap (20) unless damage is visible.

#### **CLEANING**

See Cleaning Instructions, para.2-10.

#### **INSPECTION**

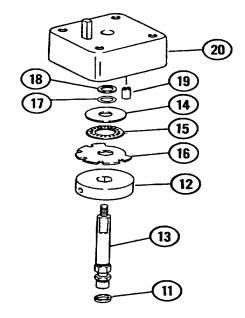
See Inspection Instructions, para.2-11.

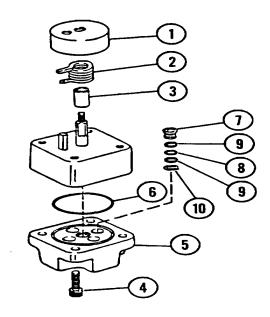
# **ASSEMBLY**

#### **NOTE**

Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. INSTALL SHAFT (13) IN CAP (20) WITHPARTS (1-3 AND 19).
  - a. If removal was necessary, install stop pin (19) in cap (20).
  - b. Install back-up ring (18) and new O-ring (17) in bore of cap (20).
  - c. Slide shaft (13) through hole in cap (20).Install bushing (3) on shaft (13).
  - d. Use pliers to install spring (2) on shaft (13).
  - e. Install hub (1).
- 2. ASSEMBLE PARTS (4-18).
  - a. Install bearing race (14) and bearing (15).
  - b. Install stop plate (16). Ensure that stop pin (19) is centered in wide gap of plate (16).





# 16-8. FRAME TILT VALVE - REPAIR (Cont'd)

- c. Install disk assembly (12) on shaft (13). The side of disk assembly (12) with holes drilled through it must face away from cap (20). Ensure that one of two holes drilled on outer surface of disk assembly (12) align with stop pin (19).
- d. Install shaft washer (11) on shaft (13).
- e. Install four seal springs (10), eight back-up rings (9), four new O-rings (8) and four seals (7) in body (4).
- f. Install new O-ring (6) in groove on body (5).
- g. Install body (5) to cap (20). Install four socket head screws (4).
- 3. INSTALL FRAME TILT VALVE, TM10-3930-660-20.

#### 16-9. FRAME TILT CYLINDER - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

# **INITIAL SETUP:**

#### **Tools**

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and Attachment Hoist; Spanner Wrench, Fork Sideshift Cylinder - Outer Gland; Spanner Wrench, Fork Sideshift Cylinder - Outer Piston; Spanner Wrench, Boom Lift Cylinder and Boom Extend Cylinder

# **Equipment Condition**

Frame tilt cylinder removed, TM10-3930-660-20.

# Materials/Parts

Container
Dry Cleaning Solvent P-D-680 (App.B, Item 48)
Hydraulic Oil (App.B, Item 35)
Lint-Free Rags (App.B, Item 38)
Loctite #271 (App.B, Item 43)
Nut (14)
O-rings (5, 6, 7, 11, 16)
Seal (13)

# **DISASSEMBLY**

 USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.

# **WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (1) and allow pressure to escape before removing valve entirely.

# 16-9. FRAME TILT CYLINDER - REPAIR (Cont'd

#### **NOTE**

Note and mark location of counterbalance valves (1) for use during assembly. The valves (1) are not interchangeable.

- 2. RELIEVE PRESSURE IN CYLINDER BY SLOWLY REMOVING TWO COUNTERBALANCE VALVES (1).DRAIN RESIDUAL OIL THROUGH VALVE HOLES INTO A SUITABLE CONTAINER.
- 3. REMOVE BACK-UP RINGS (2 AND 3), TWO BACK-UP RINGS (4), AND THREE O-RINGS (5-7) FROM EACH COUNTERBALANCE VALVE (1).DISCARD O-RINGS (5-7).
- 4. DISASSEMBLE CYLINDER PARTS (8-19).

#### **CAUTION**

Do not scratch or damage the wear surface of rod (8), piston (15) or gland (9). Follow this precaution to prevent failure of the cylinder.

- a. Use a suitable tool to pull rod (8) out approximately 5 inches for removal of gland (9).
- b. Place a container under gland (9) to catch oil contained in cylinder.
- c. Use a spanner wrench to remove gland (9) from cylinder tube (10). Pull gland (9) out of cylinder far enough to unseat O-ring (11). Allow oil to drain into container.

# **CAUTION**

Use care when removing rod (8) and piston assembly to prevent wear ring (12) damage. Keep rod (8) in line with cylinder tube to prevent binding.

d. Remove rod (8) and piston assembly from cylinder tube (10).

# 16-9. FRAME TILT CYLINDER - REPAIR (Cont'd)

- e. Place rod (8) and piston assembly on suitable supports to prevent damage.
- f. Remove two wear rings (12).

# **CAUTION**

Do not nick or scratch seal groove during removal of seal (13). Failure to follow this precaution will cause part damage.

g. Cut seal (13) and discard.

# **NOTE**

The nut (14) may need to be heated with a torch for removal.

- h. Remove nut (14) and piston (15). Discard nut (14).
- Remove and discard O-ring (16) from piston (15) hore
- j. Slide gland (9) off rod (8).
- k. Remove O-ring (11) and back-up ring (17) from gland (9). Discard O-ring (11).

#### **CAUTION**

Do not nick or scratch seal groove during removal of seal (18) and rod wiper (19). Failure to follow this precaution will cause part damage.

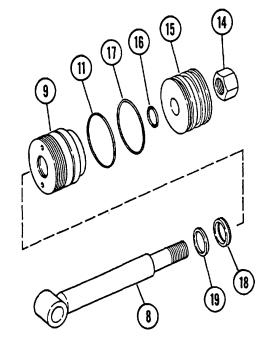
# **NOTE**

Note direction that lip of seal (18) is facing before removal.

1. Remove seal (18) and rod wiper (19) from inside of gland (9).

#### **CLEANING**

See Cleaning Instructions, para.2-10.



# **INSPECTION**

See Inspection Instructions, para.2-11.

### 16-9. FRAME TILT CYLINDER - REPAIR (Cont'd)

#### **ASSEMBLY**

#### **NOTE**

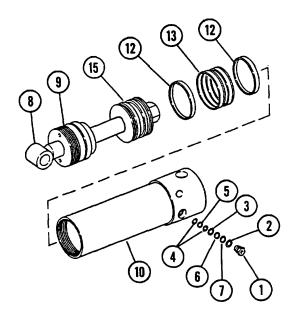
Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

# 1.ASSEMBLE CYLINDER PARTS (1-19).

- a. Install seal (18) and rod wiper (19) inside gland (9). Ensure that seal (18) lip is positioned the same way as it was before disassembly.
- b. Install back-up ring (17) and new O-ring (11) on outside diameter of gland (9).
- c. Slide gland (9) onto rod (8).
- d. Lubricate piston (15) inner diameter with clean hydraulic oil. Install new O-ring (16) inside bore of piston (15).
- e. Use a cleaning solvent and lint free rag to clean threads on rod (8) and new nut (14).
- f. Slide piston (15) onto rod (8).
- g. Apply Loctite #271 on threads of rod (8) and nut (14).Install nut (14) on rod (8).
- h. Place rod (8) and piston assembly on suitable supports to prevent damage during assembly.
  - Install two wear rings (12) and one new seal (13). Position wear rings so that gaps are 180 degrees apart.

#### **CAUTION**

Use care when installing rod (8) and piston assembly. Keep rod (8) in line with cylinder tube (10) to prevent binding. Failure to follow this precaution will cause part damage.



- j. Lubricate cylinder tube (10) inner diameter, piston (15) outside diameter and gland (9) outside diameter wiht clean hydraulic oil.
- k. Position rod (8) and piston assembly in cylinder tube (10).

#### **NOTE**

Tighten gland (9) so that it is flush with end of cylinder tube (10).Do not overtighten gland (9).

- 1. Tighten gland (9) onto cylinder tube (10).
  - m. Install back-up rings (2 and 3), two back-up rings (4) and three new O-rings (5-7) on each counterbalance valve (1).
  - n. Install two counterbalance valves (1) in cylinder tube (10) as noted during disassembly.
- 2. INSTALL FRAME TILT CYLINDER, TM10-3930-660-20.

#### 16-10. CARRIAGE TILT CYLINDER - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

### **INITIAL SETUP:**

# Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and Attachment Hoist; Spanner Wrench, Fork Sideshift Cylinder - Outer Gland; Spanner Wrench, Fork Sideshift Cylinder - Outer Piston; Spanner Wrench, Boom Lift Cylinder and Boom Extend Cylinder

# **Equipment Condition**

Carriage tilt cylinder removed, TM10-3930-660-20.

# Materials/Parts

Seals (7)

Container
Dry Cleaning Solvent P-D-680 (App. B, Item 48)
Hydraulic Oil (App. B, Item 35)
Lint-Free Rags (App. B, Item 38)
Loctite #271 (App. B, Item 43)
Nut (8)
O-rings (5, 11)

#### **DISASSEMBLY**

 USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.

#### **WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (1) and allow pressure to escape before removing valve entirely.

2. RELIEVE PRESSURE IN CYLINDER BY SLOWLY REMOVING COUNTERBALANCE VALVE (1).DRAIN RESIDUAL OIL THROUGH VALVE HOLE INTO A SUITABLE CONTAINER.

# 16-10. CARRIAGE TILT CYLINDER - REPAIR (Cont'd)

3. DISASSEMBLE CYLINDER PARTS (2-16).

# **CAUTION**

Do not scratch or damage the wear surface of rod (2), piston (10) or gland (3). Follow this precaution to prevent failure of the cylinder.

- a. Use a suitable tool to pull rod (2) out approximately 5 inches for removal of gland (3).
- b. Place a container under gland (3) to catch oil contained in cylinder.
- c. Use a spanner wrench to unscrew gland (3) from cylinder tube (4). Pull gland (3) out of cylinder far enough to unseat O-ring (5). Allow oil to drain into container.

#### **CAUTION**

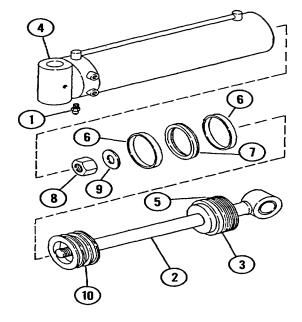
Use care when removing rod (2) and piston assembly to prevent wear ring (6) damage. Keep rod (2) in line with cylinder tube to prevent binding.

- d. Remove rod (2) and piston assembly from cylinder tube (4).
- e. Place rod (2) and piston assembly on suitable supports to prevent damage.
- f. Remove two wear rings (6).

# **CAUTION**

Do not nick or scratch seal groove during removal of seal (7).Failure to follow this precaution will cause part damage.

g. Cut seal (7) and discard.



# 16-10. CARRIAGE TILT CYLINDER - REPATR (Cont'd)

# **NOTE**

The nut (8) may need to be heated with a torch for removal.

- h. Remove nut (8) and washer (9). Discard nut (8).
- Remove piston (10) and discard 0-ring (11).Discard O-ring (11).
- j. Remove washer (12) and slide gland (3) off rod (2).
- k. Remove O-ring (5) and back-up ring (13) from gland (3). Discard O-ring (5).

# **CAUTION**

Do not nick or scratch seal groove during removal of seal (14) and rod wiper (15). Failure to follow this precaution will cause part damage.

#### **NOTE**

Note direction that lip of seal (14) is facing before removal.

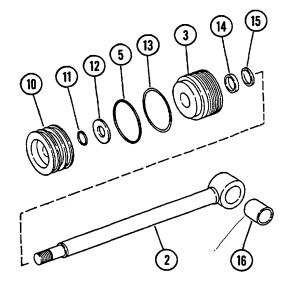
- 1. Remove seal (14) and rod wiper (15) from inside of gland (3).
  - m. Remove bushing (16).

#### **CLEANING**

See Cleaning Instructions, para.2-10.

# **INSPECTION**

See Inspection Instructions, para.2-11.



# 16-10. CARRIAGE TILT CYLINDER - REPAIR (Cont'd)

#### **ASSEMBLY**

# **NOTE**

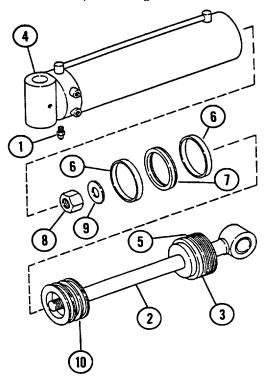
Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. ASSEMBLE CYLINDER PARTS (1-16).
  - a. Install bushing (16).
  - b. Install seal (14) and rod wiper (15) inside gland (3). Ensure that seal (14) lip is positioned the same way as it was before disassembly.
  - c. Install back-up ring (13) and new O-ring (5) on outside diameter of gland (3).
  - d. Slide gland (3) and washer (12) onto rod (2).
  - e. Lubricate piston (10) inner diameter with clean hydraulic oil. Install new O-ring (11) inside bore of piston (10).
  - f. Use cleaning solvent and lint free rag to clean threads on rod (2) and new nut (8).
  - g. Slide piston (10) onto rod (2).
  - h. Apply Loctite 1271 on threads of rod (2) and nut (8).Install nut (8) and washer (9) on rod (2).
  - i. Place rod (2) and piston assembly on suitable supports to prevent damage during assembly.
  - j. Install two wear rings (6) and one new seal (7) on piston (10). Position wear rings so that gaps are 180 degrees apart.

#### **CAUTION**

Use care when installing rod (2) and piston assembly. Keep rod (2) in line with cylinder tube (4) to prevent binding.

Failure to follow this precaution will cause part damage.



- k. Lubricate cylinder tube (4) inner diameter, piston (10) outside diameter and gland (3) outside diameter with clean hydraulic oil.
- 1. Position rod (2) and piston assembly in cylinder tube (4).

#### NOTE

Tighten gland (3) so that it is flush with end of cylinder tube (4).Do not overtighten gland.

- m. Tighten gland (3) onto cylinder tube (4).
- n. Install counterbalance valve (1) in cylinder tube(4) as noted during disassembly.
- 2. INSTALL CARRIAGE TILT CYLINDER, TM10-3930-660-20.

#### 16-11. CARRIAGE ASSEMBLY - REPLACE

#### This task covers:

- a. Removal
- b. Installation

#### **INITIAL SETUP:**

#### **Tools**

Tool Kit, Automotive Mechanics

Lifting Device, 2 Ton Capacity

Cap and Plug Set

# **Equipment Condition**

MLRS attachment fully lowered. Backrest removed, TM10-3930-660-10. Fork autoleveler switch removed TM10-3930-660-20.

# Material/Parts

Anti-seize Compound (App. C, Item 3) Locknut (4, 8) Tags (App. B, Item 52) Wood Blocks

#### Reference

TM10-3930-660-10

#### **REMOVAL**

# **WARNING**

At operating temperatures, hydraulic oil is hot and under pressure. Hot oil can cause injuries. Allow hydraulic oil to cool before disconnecting any hydraulic lines.

# **CAUTION**

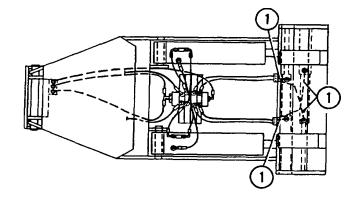
Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

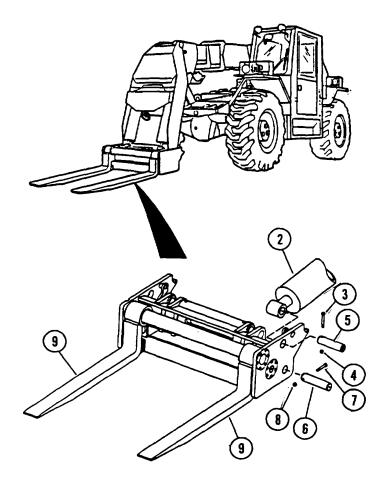
# **NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

# 16-11.CARRIAGE ASSEMBLY - REPLACE (Cont'd)

- TAG AND DISCONNECT FOUR HOSES (1) FROM FORK SIDESHIFT CYLINDERS.
- 2. DISCONNECT CARRIAGE TILT CYLINDERS (2).
  - Attach carriage assembly to a hoist through a suitable sling.
  - b. Take up slack in lifting sling to allow hoist to support carriage assembly.
  - c. Remove capscrew (3) and locknut (4) from tilt cylinder pivot pin (5). Discard locknut (4).
  - d. While supporting tilt cylinder (2) to prevent it from dropping, remove tilt cylinder pivot pin (5) using a pin puller.
  - e. Carefully lower tilt cylinder (2) onto MLRS frame.
  - Repeat STEPS a-e for tilt cylinder on other side
- 3. START ENGINE, TM10-3930-660-10.
- 4. RETRACT CARRIAGE TILT CYLINDERS (2).
- SLOWLY LOWER BOOM UNTIL BASE OF CARRIAGE JUST CONTACTS THE GROUND, AND FORK TIPS ARE ABOUT ONE INCH ABOVE THE GROUND.THIS TAKES WEIGHT OFF OF CARRIAGE PIVOT PINS (6).
- 6. SHUT OFF ENGINE, TM10-3930-660-10.
- 7. PLACE WOOD BLOCK UNDER EACH FORK
- REMOVE CARRIAGE PIVOT PINS (6).
  - a. Remove capscrew (7) and locknut (8) from carriage pivot pin (6). Discard locknut (8).
  - Remove carriage pivot pin (6) using suitable pin puller.





# 16-11. CARRIAGE ASSEMBLY - REPLACE (Cont'd)

- c. Repeat STEPS a and b to remove second carriage pivot pin (6).
- SEPARATE CARRIAGE ASSEMBLY FROM MLRSATTACHMENT.
- 10. IF NECESSARY, REMOVE FORKS (9), PARA. 18-17.
- 11. IF NECESSARY, REMOVE FORK SIDESHIFT CYLINDERS, PARA.18-31.

#### **INSTALLATION**

#### **NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on valve and hoses clean and dry.

- IF REMOVED, INSTALL FORK SIDESHIFT CYLINDERS, PARA.18-31.
- 2. IF REMOVED, INSTALL FORKS (9), PARA.18-17.
- 3. USING A HOIST AND SUITABLE SLING, MOVE CARRIAGE ASSEMBLY INTO POSITION ON MLRS ATTACHMENT.
- 4. INSTALL CARRIAGE PIVOT PINS (6).
  - a. Operate hoist as necessary to align mounting holes in carriage and MLRS frames.

#### **NOTE**

Apply anti-seize compound on pins (6) as installed.

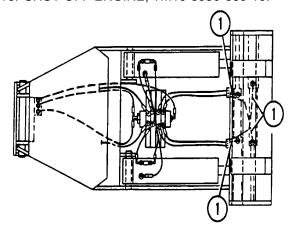
- b. Install two carriage pivot pins (6), two capscrews (7) and two new locknuts (8).
- 5. CONNECT FOUR HYDRAULIC LINES (1) TO FORK SIDESHIFT CYLINDERS.
- 6. START ENGINE, TM10-3930-660-10.

7. EXTEND CARRIAGE TILT CYLINDERS (1) TO ALIGN PIVOT PIN HOLES IN CARRIAGE FRAME AND IN CYLINDER ROD ENDS.

#### NOTE

Apply anti-seize compound on pins (5).

- 8. INSTALL TWO CARRIAGE TILT CYLINDER PIVOT PINS (5), TWO CAPSCREWS (3) AND TWO NEW LOCKNUTS (4).
- 9. SHUT OFF ENGINE, TM10-3930-660-10.
- 10. DISCONNECT HOIST AND REMOVE LIFTING SLING FROM CARRIAGE FRAME.
- 11. INSTALL FORK AUTOLEVELER SWITCH, TM10-3930-660-20.
- 12. INSTALL BACKREST, TM10-3930-660-10.
- 13. LUBRICATE CARRIAGE TILT CYLINDER PIVOT PINS (4) AND CARRIAGE PIVOT PINS (5), L05-3930-660-12.
- 14. START ENGINE, TM10-3930-660-10.
- 15. OPERATE FORK SIDESHIFT FUNCTION SEVERAL TIMES IN EACH DIRECTION TO BLEED FORK SIDESHIFT LINES OF AIR.
- 16. SHUT OFF ENGINE, TM10-3930-660-10.



#### 16-12.BOOM ASSEMBLY - REPLACE

### This task covers:

- a. Removal
- b. Installation

#### **INITIAL SETUP:**

#### Tools

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

Lifting device, 5 ton

Cap and Plug Set

# **Equipment Condition**

MLRS attachment cylinder removed,

Two personnel

TM10-3930-660-20.

MLRS attachment removed,

TM10-3930-660-20.

Transmission cover removed, TM10-

3930-660-20.

Boom assembly fully retracted.

#### Materials/Parts

Anti-seize Compound (App.B, Item 3) Container Lockwashers (6) Locknuts (15), (18), (a) Loctite 242 (App. B, Item 41) Tags (App. B, Item 52) Wood Blocks

# Personnel Required

#### **NOTE**

In this procedure, the inner, intermediate, and outer boom sections are removed as a unit. For removal of individual boom sections, refer to paragraphs 16-12. 1, 16-12. 2, and 16-12. 3.

# WARNING

Hydraulic oil in the system can be under pressures over 3000 psi with the engine OFF.ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF and MLRS attachment on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

# 16-12. BOOM ASSEMBLY - REPLACE (Cont'd)

# **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

#### **NOTE**

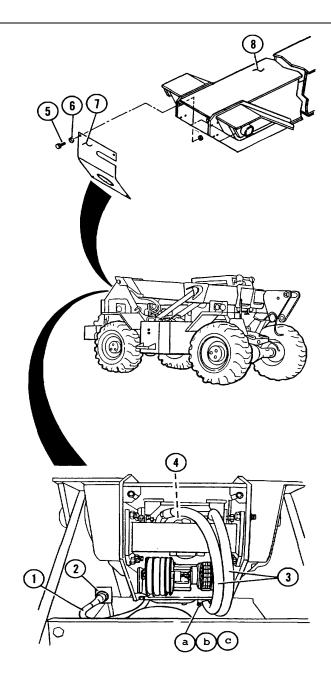
If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use container to catch any hydraulic oil that may drain from system.

#### **NOTE**

Weight of boom assembly including boom extend cylinder is approximately 4100 lbs.

#### **REMOVAL**

- DISCONNECT BOOM ELECTRICAL CABLE (1)FROM SOCKET (2) ON VEHICLE FRAME.
- 2. DISCONNECT TWO HOSES (3) FROM BOOM EXTEND CYLINDER (4).
  - a. Remove four bolts (5), four lockwashers (6), and cover (7), from rear of boom assembly (8). Discard lockwashers (6).
  - b. Tag and disconnect two hoses from boom extend cylinder (4). Close hoses (3) securely with metal caps.
  - c. Remove locknuts (a), capscrews (b), and clamp halves (c) securing hydraulic hoses (3) to bottom of boom assembly.
- 3. DISCONECT THREE HOSES (9) FROM LINES (10) AT UNDERSIDE OF BOOM ASSEMBLY (8).



# 16-12. BOOM ASSEMBLY - REPLACE (Cont'd)

# **WARNING**

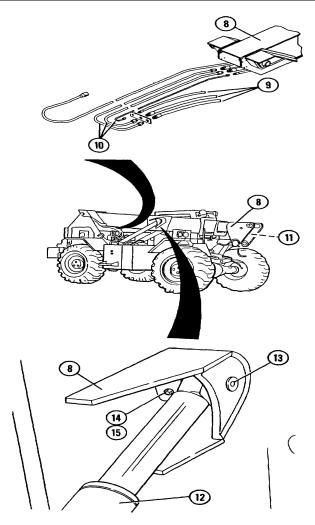
Before performing step 3a, make sure hoses (11) at front of boom assembly (8) are closed securely using metal plugs. Hydraulic oil under pressure can spray from hoses (11) causing bodily injury if hoses are not closed securely.

a. Start engine and raise boom assembly (8) as necessary to access hoses (9). Stop engine.

# **WARNING**

Disconnect hoses (9) carefully during step lb. Hydraulic oil may be under pressure.

- b. Tag and disconnect three hoses (9) from lines (10) at underside of boom assembly (8). Plug three hoses (9) with metal caps.
- 4. DISCONNECT ROD END OF BOOM HOIST CYLINDERS (12) FROM BOOM ASSEMBLY (8).
  - a. Start engine. Lower boom assembly (8) until cylinder pivot pins (13) are just above cab. Stop engine.
  - b. Support boom assembly (8) with hoist and slings or other suitable lifting device positioned at front of boom assembly (8).
  - Place wood block across vehicle deck behind cab to support boom hoist cylinders (12) when cylinders are lowered.



# 16-12.BOOK ASSEMBLY - REPLACE (Cont'd)

- d. Remove capscrew (14) and locknut (15) securing pivot pin (13) to boom hoist cylinder (12). Discard locknut (15).
- e. Support boom hoist cylinder (12). Remove pivot pin (13) from boom assembly (8) and boom hoist cylinder (12).

#### NOTE

In step 4f, release hydraulic joystick immediately after boom hoist cylinder (12) to be removed has fully retracted. If joystick is allowed to remain open, the other cylinder will start to retract, putting extreme stress on lifting equipment and boom assembly (8).

- f. Start engine and run at full throttle. Fully retract boom hoist cylinder using joystick. Cylinder (12) will retract very slowly. Stop engine.
- g. Carefully lower cylinder (12) onto board placed across vehicle deck so hydraulic line on cylinder is not damaged.
- h. Repeat steps 4d through 4g for other cylinder (6).
- 5. PLACE JACKSTAND OR SUPPORT ON FRONT OF VEHICLE DECK.ADJUST SUPPORT SO THAT BOOM ASSEMBLY (8) WILL BE LEVEL WHEN LOWERED.
- 6. CAREFULLY LOWER BOOM ASSEMBLY (8) WITH HOIST AND SLING UNTIL FRONT OF OUTER BOOM SECTION IS ON JACKSTAND OR OTHER SUITABLE SUPPORT.

# 16-12. BOCM ASSEMBLY - REPLACE (Cont'd)

7. REMOVE BOOM ASSEMBLY (8) FROM VEHICLE FRAME.

# **NOTE**

Center of gravity for boom assembly is approximately 9 feet from rear end of boom assembly (8).

#### **CAUTION**

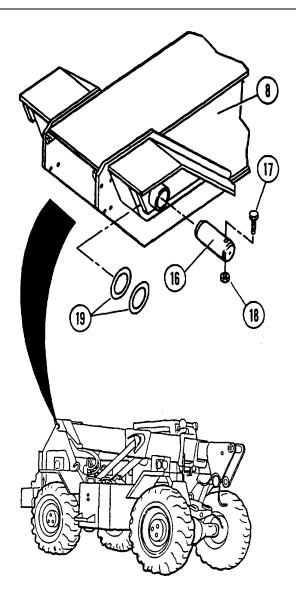
To prevent damage to lines (10) and electrical cable (1) during step 5a, place wood boards between underside of outer boom section and slings.

- a. Reposition hoist and slings to center of gravity for boom assembly (8). Carefully raise boom assembly (8) until weight of boom is removed from boom pivot pins (16).
- b. Remove capscrew (17) and locknut (18) securing boom pivot pin (16) to vehicle frame. Discard locknut (18).

# **NOTE**

Shims (19) may fall out as pivot pins (16) are removed.

- c. Remove boom pivot pin (16) from boom assembly (8) and vehicle frame.
- d. Remove shims (19) from between boom assembly (8) and vehicle frame. Note quantity and position of shims (19) for use during installation.
- e. Repeat steps 7b through 7d for other boom pivot pin.



# 16-12. BOOM ASSEMBLY - REPLACE (Cont'd)

# **CAUTION**

Be careful that lines (10) and electrical cable (1) on underside of outer boom section are not damaged when boom assembly (8) is lowered onto supports.

f. Carefully remove boom assembly (8) from vehicle frame and lower boom assembly (8) onto supports.

#### **INSTALLATION**

#### NOTE

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on hydraulic components and hoses clean and dry.

 INSTALL BOOM ASSEMBLY (8) TO VEHICLE FRAME.

#### **NOTE**

Center of gravity for boom assembly (8) is approximately 9 feet from rear end of boom assembly (8).

# **CAUTION**

To prevent damage to lines (10) and electrical cable (1) during step la, place wood boards between underside of outer boom section and slings.

 a. Carefully lift boom assembly (8) into position over vehicle with hoist and sling or other suitable lifting device. Lower boom assembly (8) as required to align boom pivot pin holes.

# **NOTE**

Apply anti-seize compound to boom pivot pin (16) as installed.

b. Position shims (19) between outer boom section and inside surface of vehicle frame. Install boom pivot pin (16).

# 16-12.BOOM ASSEMBLY - REPLACE (Cont'd)

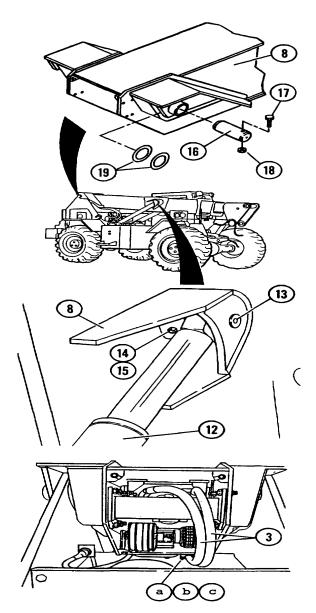
- c. Secure boom pivot pin (16) to vehicle frame with capscrew (17) and new locknut (18).
- d. Repeat steps lb and lc for other pivot pin (16).
- PLACE JACKSTAND OR SUPPORT ON FRONT OF VEHICLE DECK.ADJUST SUPPORT SO BOOM ASSEMBLY (8) IS LEVEL WHEN LOWERED.
- 3. CAREFULLY LOWER BOOM ASSEMBLY (8) WITH HOIST AND SLING UNTIL FRONT OF OUTER BOOM SECTION IS ON JACKSTAND OR SUPPORT.
- 4. SECURE HYDRAULIC HOSES (3) TO BOTTOM OF BOOM ASSEMBLY WITH NEW LOCKNUTS (a), CAPSCREWS (b), AND CLAMP HALVES (c).
- 5. CONNECT ROD ENDS OF BOOM HOIST CYLINDERS (12) TO BOOM ASSEMBLY (8).
  - a. Reposition slings to front of outer boom section.
  - b. Lift boom assembly (8) until cylinder pivot pin holes of boom assembly (8) are just above cab.
  - c. Lift boom hoist cylinders (12) into position and support cylinders.

# **CAUTION**

Use hoist and sling to make final alignment with cylinder rod eye and pivot pin hole. Do not use the joystick to make final alignment; damage to rod eye bushing could result.

#### NOTE

One boom hoist cylinder (12) will begin to extend before the other. Install this cylinder first. Second cylinder will begin to extend after first cylinder is connected.



# 16-12.BOOM ASSEMBLY - REPLACE (Cont'd)

d. Start engine. Use joystick to extend boom hoist cylinder (12) until cylinder rod eye is aligned with pivot pin hole of boom assembly (8). Stop engine.

# **NOTE**

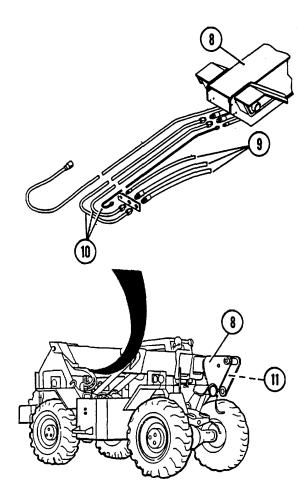
Apply anti-seize compound to pivot pin (13) as installed.

- e. Install pivot pin (13).
- f. Secure pivot pin (13) to boom assembly (8) with capscrew (14) and new locknut (15).
- g. Repeat steps 4d through 4f for other boom hoist cylinder (12).
- 6. CONNECT THREE HOSES (9) TO LINES (10) AT UNDERSIDE OF BOOM ASSEMBLY (8).
  - a. Start engine and raise boom assembly (8) as required to access lines (10). Stop engine.

# **WARNING**

Remove hose caps carefully prior to connecting hoses (9) in step 5b. Hydraulic oil may be under pressure.

- b. Connect three hoses (9) to three lines (10) at underside of boom assembly (8).
- 7. START ENGINE AND LOWER BOOM ASSEMBLY (8) UNTIL HORIZONTAL.STOP ENGINE.



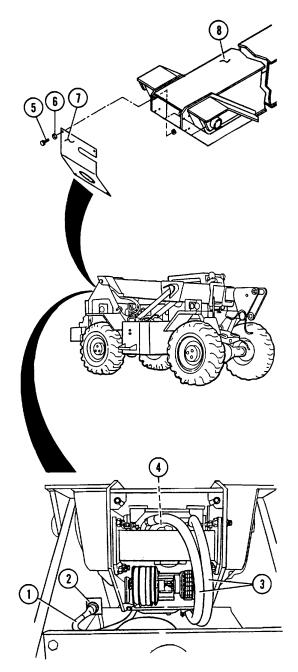
# 16-12.BOOM ASSEMBLY - REPLACE (Cont'd)

- 8. CONNECT TWO HOSES (3) TO BOOM EXTEND CYLINDER (4).
  - a. Connect two hoses (3) to boom extend cylinder (4) as tagged.

### **NOTE**

Apply Loctite #242 to threads of bolts (5) as installed.

- b. Place cover (7) on rear of boom assembly (8) and secure with four bolts (5) and four new lockwashers (6).
- 9. CONNECT BOOM ELECTRICAL CABLE (1) TO SOCKET (2) ON VEHICLE FRAME.'
- 10. INSTALL MLRS ATTACHMENT, TM10-3930-660-20.
- 11. INSTALL MLRS ATTACHMENT CYLINDER, TM10-3930-660-20.
- 12. INSTALL TRANSMISSION COVER, TM10-3930-660-20.
- 13. LUBRICATE BOOM PIVOT PINS AND BOOM HOIST CYLINDER UPPER PIVOT PINS, LO10-3930-660-12.



### 16-12.1. INNER BOOK - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

### **Initial Setup**

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Cap and Plug Set

Lifting Device (Capacity 2 ton)

### **Equipment Condition**

MLRS Attachment removed, TM10-3930-660-20. MLRS attachment cylinder removed, TM10-3930-660-20. Transmission cover removed, TM10-3930-660-20. Boom level and retracted

### Materials/Parts

Anti-seize Compound (App. B, Item 3)
Container
Cotter Pin (61)
Electrical Tape (App. B, Item 53)
Lint-Free Rags (App. B, Item 38)
Lockwashers (9), (22), (28), (42), (47), (54)
Loctite #242 (App. B, Item 41)
Rope, 30 ft.
Tags (App.B, Item 52)
Wood Blocks

# Personnel Required

Three personnel

# WARNIN

G

Hydraulic oil in the system can be under pressures over 3000 psi with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF and MLRS attachment on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

### **WARNING**

At operating temperatures, hydraulic oil is hot and under pressure. Hot oil can cause injuries. Allow hydraulic oil to cool before disconnecting any hydraulic lines.

### **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

### **NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

### NOTE

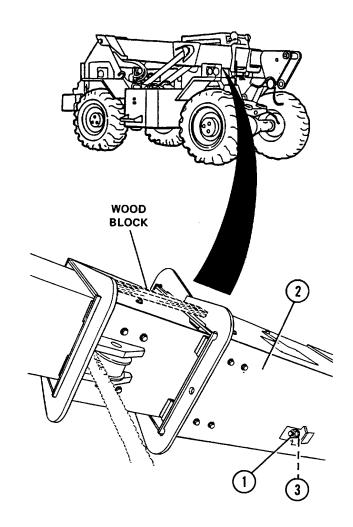
Combined weight of outer boom weldment and boom extend cylinder is approximately 1500 lbs.

### **REMOVAL**

### NOTE

Count and record number of turns nut (1) is loosened in step 1.

 LOOSEN, BUT DO NOT REMOVE NUT (1) ON UNDERSIDE OF OUTER BOOM (2) TO RELIEVE TENSION ON EXTENDED CHAIN (3).

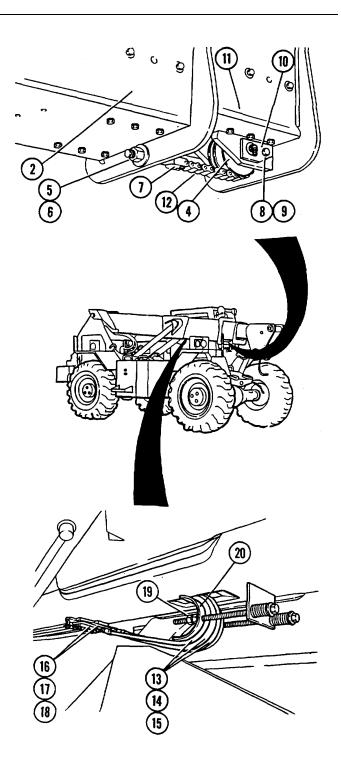


2. REMOVE RETRACT CHAIN PULLEY (4).

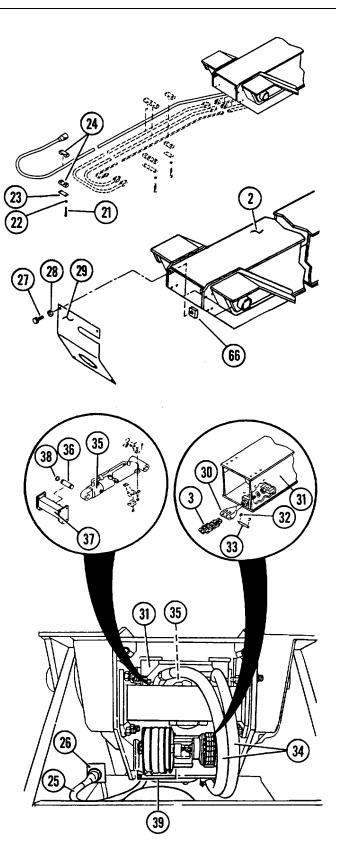
### NOTE

Record number of turns nut (5) is loosened in step 2a for use during installation.

- a. Remove nut (5) and flatwasher (6) securing clevis (7). Remove clevis (7) from outer boom (2).
- b. Remove capscrew (8), and lockwasher (9). Remove pin (10) and chain pulley (4) from intermediate boom (11). Discard lockwasher (9).
- c. Lift retract chain (12) through hole and over flange of intermediate boom (11). This will allow retract chain (12) to fall freely when inner boom is removed.
- 3. TAG AND DISCONNECT HOSES (13, 14, and 15), FROM LINES (16, 17 and 18).
  - a. Loosen four nuts (19) at tensioner (20) to relieve tension on hoses (13, 14, and 15).
  - b. Tag and disconnect hoses (13, 14, and 15) from lines (16, 17, and 18).
  - c. Close end of lines (16, 17, and 18) with metal plugs.
- 4. REMOVE FOUR BOOM ELECTRICAL CABLE CLAMP ASSEMBLIES (PARTS 21-24).
  - a. Remove two capscrews (21) and two lockwashers (22) securing spacer plate (23) and clamp halves (24). Discard lockwashers.
  - b. Repeat step 4a for all remaining electrical cable clamp assemblies under boom.



- 5. DISCONNECT BOOM ELECTRICAL CABLE (25) FROM SOCKET (26) ON VEHICLE FRAME.
- 6. REMOVE FOUR BOLTS (27), FOUR LOCKWASHERS (28), AND COVER (29) FROM REAR OF OUTER BOOM (2) DISCARD LOCKWASHERS (28). IF NECESSARY REMOVE RETAINER (66).
- 7. SEPARATE EXTEND CHAIN (3) FROM CLEVIS (30) AT REAR OF INNER BOOM (31).
  - a. Remove retaining ring (32) from pin (33).
  - b. Remove pin (33) from clevis (30) and separate extend chain (3) from clevis (30).
- 8. TAG AND REMOVE TWO HOSES (34) FROM BOOM EXTEND CYLINDER (35).
- PLACE WOOD BLOCK UNDER BOOM EXTEND CYLINDER (35), BETWEEN CYLINDER (35) AND INNER BOOM (31). WOOD BLOCK WILL SUPPORT CYLINDER (35) WHEN PIN (36) IS REMOVED.
- 10. DISCONNECT PIN (36) SECURING BASE OF BOOM EXTEND CYLINDER (35) TO ANCHOR (37).
  - a. Remove two retaining rings (38) from pin (36).
  - b. Slide pin (36) right or left through hole in anchor (37) until p: (36) touches outer boom (2).
- 11. CAREFULLY PULL HOSES (13, 14, AND 15) FROM UNDERSIDE OF HOSE PULLEY (39) OUT THE REAR OF OUTER BOOM (2).
- 12. REMOVE BOOM ELECTRICAL CABLE (25) FROM OUTER BOOM (2).
  - a. Tie one end of a rope to anchor (37) at rear of outer boom (2).



- b. Tie other end of rope to hose pulley support bracket (40).
- c. Using chain, rope, or hand winch, attach inner boom (31) and intermediate boom (11) together at flanges.
- d. Pull inner boom (31) and intermediate boom (11) out as an assembly until boom hose pulley (39) and rope end are visible through hole near tensioner (20).
- e. Until rope from hose pulley support bracket (40). Tie same rope end to plug end of boom electrical cable (25).
- f. Pull rope from rear of outer boom until cable (25) is not looped inside outer boom (2).

### **NOTE**

Leave rope tied to cable (25).

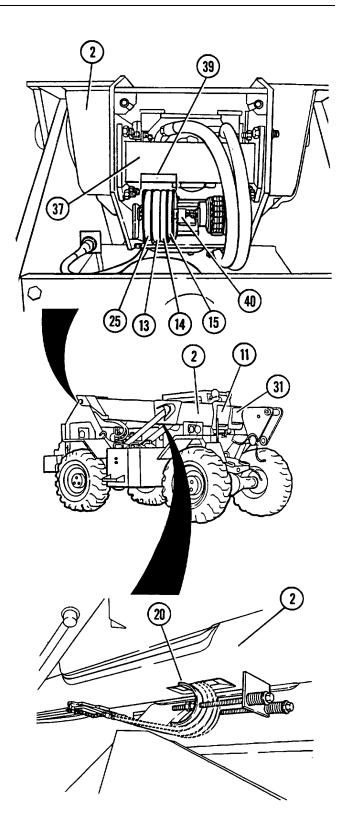
### **CAUTION**

To prevent damage to hoses (13, 14, and 15), and boom electrical cable (25), have assistant guide hoses (13, 14, and 15) out rear of outer boom (2) during step 12g.

g. Use hoist and sling (or other suitable lifting device) to push intermediate boom (11) and inner boom (31) as an assembly into outer boom (2) until intermediate boom extends approximately one foot from outer boom (2).

### NOTE

Adjust hoist and sling as required during steps 13 and 14 to provide work room when removing wear pad assemblies.



- 13. REMOVE TWO TOP WEAR PAD ASSEMBLIES (PARTS 44 and 45) FROM FRONT OF INTERMEDIATE BOOM (11).
  - a. Remove capscrews (41), lockwashers (42) and flatwashers (43). Discard lockwashers (42).

### **NOTE**

Note location and quantity of wear pad components. Tag all wear pad components as removed.

- b. Remove wear pad (44) and wear pad inserts (45).
- 14. REMOVE TWO SIDE WEAR PAD ASSEMBLIES (PARTS 49-52) FROM FRONT OF INTERMEDIATE BOOM (11).
  - a. Remove capscrews (46), lockwashers (47), and flatwashers (48). Discard lockwashers (47).



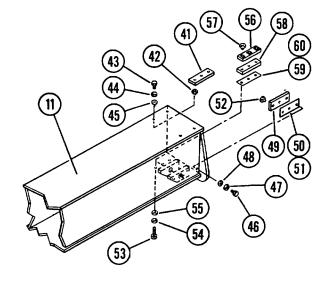
### OTE

Shims (50 and 51) are used as required. Note location and quantity of shims (50 and 51) as removed.

- b. Remove wear pad (49), shims (50) and (51), and wear pad inserts (52).
- 15. REMOVE TWO BOTTOM WEAR PAD ASSEMBLIES (PARTS 56-60) FROM FRONT OFINTERMEDIATE BOOM (11).
  - a. Remove capscrews (53), lockwashers (54), and flatwashers (55). Discard lockwashers (54).

### **NOTE**

Shims (59 and 60) are used as required. Note location and quantity of shims (59 and 60) as removed.



- b. Lift inner boom (31) and remove wear pad (56), wear pad inserts (57), spacers (58) and shims(59 and 60).
- 16. REMOVE INNER BOOM (31) FROM INTERMEDIATE BOOM (11).
  - a. Using chain, rope, or hand winch, attach outer boom (2) to intermediate boom (11).
  - b. Pull out inner boom (31) from intermediate boom (11) approximately 12 feet.

### NOTE

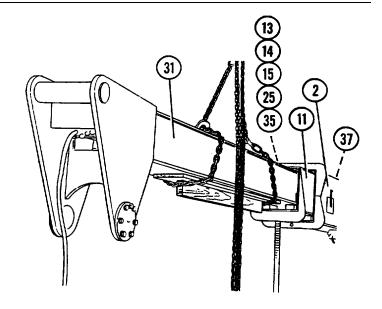
Center of gravity for inner boom (31) with extend cylinder (35) is approximately 92 inches from front end of inner boom (32).

c. Reposition hoist and sling at center of gravity for inner boom(31). Place spreader bar between slings at underside of boom (31).

### **NOTE**

Have assistant guide hoses (13, 14, and 15), and boom electrical cable (25) from intermediate boom (11) as inner boom (31) is removed.

- d. Slowly remove inner boom (31) from intermediate boom (11) while guiding hoses (13, 14, and 15), and boom electrical cable (25), from intermediate boom (11).
- e. Untie rope from boom electrical cable (25).
- f. Place inner boom (31) on supports.



### NOTE

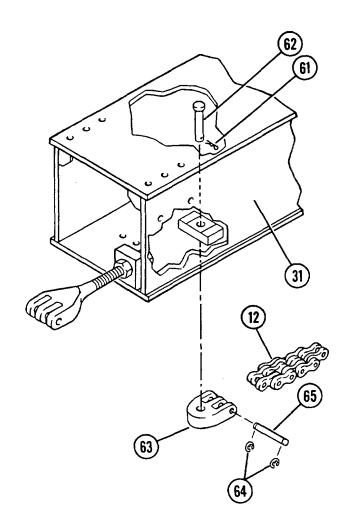
Leave other end of rope tied to anchor (37) at rear of outer boom (2). Rope will be used during installation of inner boom (31).

### **DISASSEMBLY**

- 1. REMOVE REMAINING WEAR PADS FROM INNER BOOM, IF NECESSARY, PARA.16-14.
- 2. REMOVE BOOM EXTEND CYLINDER IF NECESSARY, TM10-3930-660-20.
- 3. REMOVE BOOM HYDRAULIC HOSES FROM INNER BOOM, PARA. -
- 4. REMOVE BOOM ELECTRICAL CABLE FROM INNER BOOM, TM10-3930-660-20.
- 5. REMOVE RETRACT CHAIN (12) FROM INNER BOOM.
  - a. Remove cotter pin (61) and pin (62) securing clevis (63) to inner boom (31). Discard cotter pin (61).
  - b. Remove retaining rings (64) and pin (65) securing clevis (63) to retract chain (12).

### **CLEANING**

See Cleaning Instructions, para. 2-10.



#### INSPECTION

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

- 1. IF REMOVAL WAS NECESSARY, INSTALL BOOM ELECTRICAL CABLE TO INNER BOOM, TM10-3930-660-20.
- 2. IF REMOVAL WAS NECESSARY, INSTALL BOOM HYDRAULIC HOSES TO INNER BOOM, TM10-3930-660-20.
- 3. IF REMOVAL WAS NECESSARY, INSTALL BOOM EXTEND CYLINDER INSIDE INNER BOOM, TM10-3930-660-20.
- 4. IF REMOVAL WAS NECESSARY, INSTALL WEAR PADS TO INNER BOOM, PARA. 16-14.
- IF REMOVAL WAS NECESSARY, INSTALL RETRACT CHAIN (12) TO INNER BOOM (31).
  - a. Secure clevis (63) to retract chain with pin (65) and retaining rings (64).
  - b. Secure clevis (63) to inner boom (31) with pin (62) and new cotter pin (61).

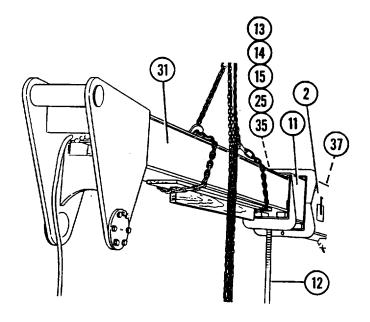
### **INSTALLATION**

### **NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on hydraulic components and hoses clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

### NOTE

Be sure that wood block placed between boom extend cylinder (35) and inner boom during inner boom removal remains in lace during inner boom installation.

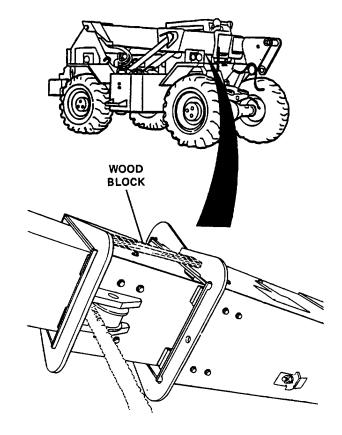


- 1. INSTALL INNER BOOM (31).
  - a. Support a 1 foot long wood block between flanges of outer boom (2) and intermediate boom (11).
  - b. Position hoist and sling (or other suitable lifting device) at center of gravity for inner boom (31). Place spreader bar between slings at underside of boom (31).
  - c. Position inner boom (31) in front of intermediate boom (11) with hoist and sling.
  - d. Tie end of rope to boom electrical cable (25).
  - e Tape ends of hoses (13, 14, and 15) to boom electrical cable (25).
  - f. Place ends of boom electrical cable (25) and hoses (13, 14, and 15) inside intermediate boom (11).
  - g. Pull cable (25) and hoses (13, 14, and 15), with rope at rear of outer boom until they are free of slack.
  - h. Put free end of retract chain (12) through pulley hole of intermediate boom (11). Allow all slack of chain (12) to hang from hole.

### **NOTE**

During step h, have assistant guide cable (25) and hoses (13, 14, and 15), into front of intermediate boom (11). Have second assistant pull rope at rear of outer boom (2). This will prevent hoses and cable from being crushed and damaged.

i. Install inner boom (31) into intermediate boom (11) approximately 3 feet.



### **NOTE**

Adjust hoist and sling as required during steps 2, 3, and 4 to provide work room when installing wear pad assemblies.

### **NOTE**

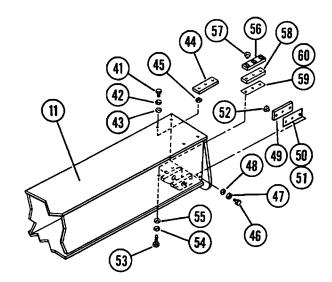
All used wear pads installed in steps 2 through 4 must be at least 3/8 inch thick. If wear pad is worn to less than 3/8 inch thick, discard old wear pad and replace with new wear pad.

2. INSTALL TWO BOTTOM WEAR PAD ASSEMBLIES (PARTS 56-60).

### NOTE

Shims (59 and 60) are used as required. Install same quantity of shims (59 and 60) as noted during removal.

- a. Lift inner boom (2) to provide adequate space between inner boom (2) and intermediate boom (11).
- b. Position spacers (58), shims (59 and 60), wear pads (56), and wear pad inserts (57) between intermediate boom (11) and inner boom (31). Chamfered side of wear pad (56) must be facing towards inner boom (31). Widest portion of wear pad (56) must be facing towards outside of intermediate boom (11).
- c. Apply Loctite 242 to capscrews (53). Secure wear pad assemblies (parts 56-60) to intermediate boom (11) with flatwashers (55), new lockwashers (54), and capscrews (53). Torque capscrews (53) to 30 lb. ft.
- 3. INSTALL TWO SIDE WEAR PAD ASSEMBLIES (PARTS 49-52).



### NOTE

Shims (50 and 51), are used as required. Install same quantity of shims (50 and 51) as noted during removal.

- a. Position wear pads (49), shims (50 and 51), and wear pad inserts (52) between intermediate boom (11) and inner boom (31). Chamfered side of wear pad (49) must be facing towards inner boom (31). Widest portion of wear pad (49) must be facing towards bottom of intermediate boom (11).
- b. Apply Loctite 242 to capscrews (49). Secure wear pad assemblies (parts 49-52) to intermediate boom (11) with flatwashers (48), new lockwashers (47), and capscrews (46). Torque capscrews (46) to 30 lb. ft.
- 4. INSTALL TWO TOP WEAR PAD ASSEMBLIES (PARTS 44 and 45).
  - a. Position wear pads (44) and wear pad inserts (45) between intermediate boom (11) and inner boom (31). Chamfered side of wear pad (44) must be facing towards inner boom (31). Widest portion of wear pad (44) must be facing towards outside of intermediate boom (11).
  - b. Apply Loctite 242 to capscrews (41). Secure wear pad assemblies (parts 44 and 45) with flatwashers (43), new lockwashers (42), and capscrews (41). Torque capscrews (41) to 30 lb. ft.

5. USING HOIST AND SLING TO MOVE INNER BOOM, CHECK FOR CLEARANCE OF 0.01 TO 0.13 INCH BETWEEN INNER BOOM SURFACE AND WEAR PADS. IF NECESSARY, ADD OR SUBTRACT SHIMS (50, 51, 59 AND 60) UNTIL CLEARANCE IS WITHIN SPECIFICATION.

#### NOTE

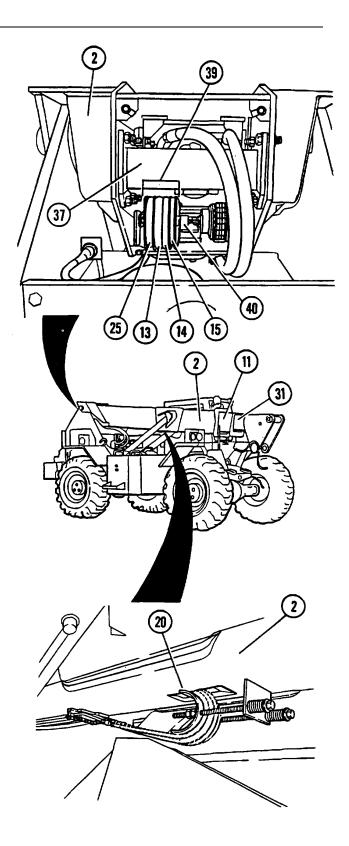
Be sure one foot long wood block placed between flanges of outer boom (2) and intermediate boom (11) during step la, is still in place.

6. PARTIALLY INSTALL INNER BOOM (31).

### **CAUTION**

To prevent damage to hoses (13, 14 and 15), and boom electrical cable (25), have assistant pull rope attached to boom electrical cable (25) and hoses (13, 14 and 15) at rear of outer boom (2).

- a. Push inner boom (31) into intermediate boom (11) until approximately 4 feet of inner boom (31) extends from front of intermediate boom (11).
- b. Position hoses (13, 14 and 15), and boom electrical cable (25) into shives on top side of hose pulley (39).
- c. Untile rope from anchor (37) a rear of outer boom (2). Tie same rope end to hose pulley support bracket (40).
- d. Using chain, rope, or hand winch, attach inner boom (2) and intermediate boom (11) together.
- e. Pull inner boom (31) and intermediate boom (11) from outer boom (2) as an assembly until boom hose pulley (39) and rope end are visible through hole near tensioner (20). 16-69



f. Untie rope end from hose pulley support bracket (40). Pull rope, hoses (13, 14 and 15), and boom electrical cable (25), through hole near tensioner until free of slack.

### CAUTION

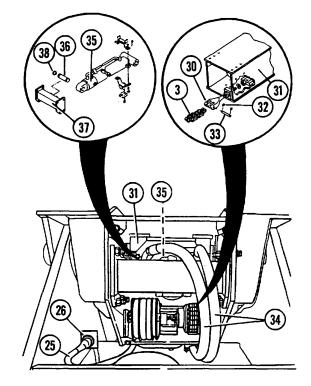
Have assistant guide hoses (13, 14, and 15) through hole near tensioner (20) while installing booms.

- g. Make sure that hoses (13, 14 and 15), and boom electrical cable (25) wrap around boom pulley (39) and remain in proper position.
- h. Push inner boom (31) and intermediate boom (11) into outer boom (2) as an assembly until outer boom is approximately one foot from flange of intermediate boom (11).
- i. Remove tape from around boom electrical cable (25) and hoses (13, 14 and 15). Until rope end from cable (25).
- 7. SECURE BASE OF BOOM EXTEND CYLINDER (35) TO ANCHOR (37).
  - a. Push inner boom (2) in until mounting hole of cylinder (35) is aligned with mounting holes of anchor, (37).

### NOTE

Apply anti-seize compound to pin (36) as installed.

- b. Secure cylinder (35) to anchor (37) by sliding pin (36) into place. Secure pin (36) with two retaining rings (38).
- c. Remove wood block from under cylinder (35).



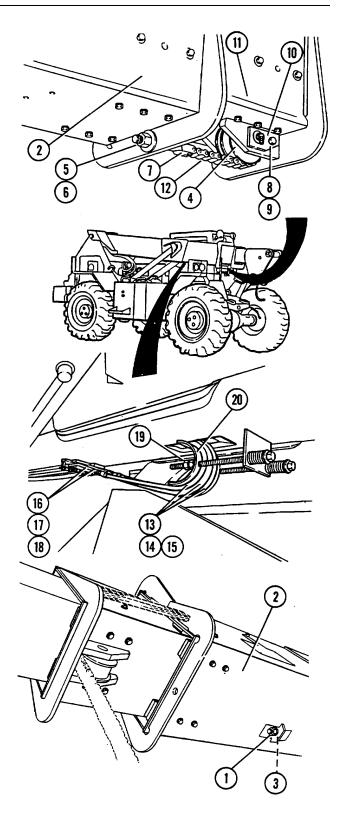
16-70

- 8. CONNECT EXTEND CHAIN (3) TO CLEVIS (30) AT REAR OF INNER BOOM (31).
  - a. Position chain (3) around extend chain sheave and align holes of chain (3) with holes in clevis (30).
  - b. Attach chain (3) to clevis (30) with pin (33).
  - c. Secure pin (33) with two retaining rings (32).
- 9. CONNECT TWO HYDRAULIC HOSES (34) TO BOOM EXTEND CYLINDER (35).
- 10. CONNECT HOSES (13, 14 AND 15) TO LINES (16, 17 AND 18) AT TENSIONER.
- 11. INSTALL RETRACT CHAIN PULLEY (4) TO FRONT OF INTERMEDIATE BOOM (11).
  - a. With retract chain (12) around pulley (4), align pulley (4) and intermediate boom holes. Install pin (10).
  - b. Apply Loctite 242 to capscrew (8).
  - c. Install capscrew (8) and new lockwasher (9).

### NOTE

Tighten nut (5) same number of turns as noted during removal.

- d. Insert clevis (7) into hole in outer boom (2) and secure with flatwasher (6) and nut (5).
- 12. TIGHTEN NUT (1) ON UNDERSIDE OF OUTER BOOM (2) TO ADJUST TENSION OF EXTEND CHAIN **(3)**, SEE TM10-3930-660-20.
- 13. ADJUST HYDRAULIC HOSE TENSION, TM10- 3930-660-20.



- 14. INSTALL FOUR BOOM ELECTRICAL CABLE CLAMP ASSEMBLIES (PARTS 21-24) TO BOOM ELECTRICAL CABLE (25).
  - a. Apply Loctite 242 to capscrews (21).
  - b. While pulling cable (25) tight, install clamp halves (24), spacer plate (23), and two capscrews (21) to outer boom, closest to tensioner (20).
  - c. Install remaining three cable clamps while pulling cable (25) tight.
- 15. CONNECT BOOM ELECTRICAL CABLE (25) TO SOCKET (26) ON VEHICLE FRAME.

### **NOTE**

Be sure that hoses (13, 14 and 15) and boom electrical cable (25) are properly routed around tensioner (20).

- 16. INSTALL MLRS ATTACHMENT, TM10-3930-660-20.
- 17. INSTALL MLRS ATTACHMENT CYLINDER, TM10-3930-660-20.

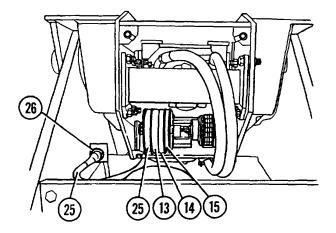
### **NOTE**

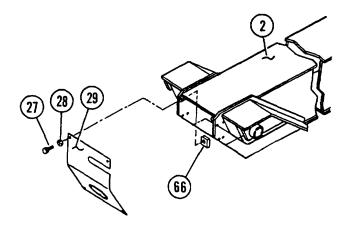
Before performing step 18, check all hydraulic boom functions for proper operation.

### **NOTE**

Apply Loctite 242 to threads of bolts (27) as installed.

- 18. IF REMOVAL WAS NECESSARY, INSTALL RETAINER (66). PLACE COVER (29) ON REAR OF OUTER BOOM (2) AND SECURE WITH FOUR BOLTS (27) AND FOUR NEW LOCKWASHERS (28).
- 19. INSTALL TRANSMISSION COVER, TM10- 3930-660-20.





### 16-12.2. NTREDIATE BOOM - REPLACE/REPAIR

This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

### Initial Setup

#### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Lifting Device (Capacity 2000 lb.)

Cap and Plug Set

### **Equipment Condition**

Inner boom removed, para. 16-12.1

### Materials/Parts

Container Lockwashers (6), (13), (21) Loctite 242 (App. B, Item 41) Wood Blocks

# Personnel Required Two Personnel

### **REMOVAL**

### WARNING

Hydraulic oil in the system can be under pressure over 3000 psi with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With the engine OFF and hydraulic attachments on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

### **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

#### NOTE

If more than one hydraulic line is removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

### 16-12.2. INTERMEDIATE BOOK - REPLACE/REPAIR (Cont'd)

#### NOTE

Be sure rope used during inner boom removal (para. 16-12.1) is placed in intermediate boom and fastened at each end.

### NOTE

The weight of the intermediate boom (1) is 830 lbs.

1. ATTACH A HOIST WITH SLINGS (OR OTHER SUITABLE LIFTING DEVICE) TO INTERMEDIATE BOOM (1). USE HOIST TO REMOVE INTERMEDIATE BOOM (1) 3/4 WAY OUT FROM OUTER BOOM (2).

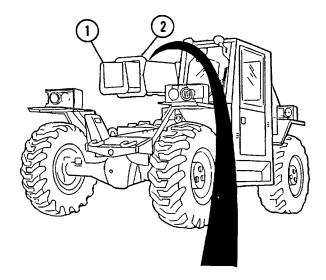
### NOTE

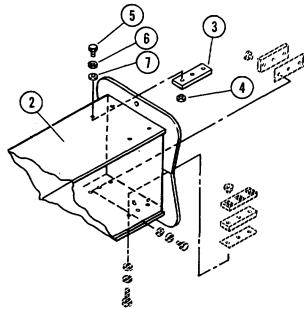
Note location and quantity of wear pad components. Tag all components as removed.

### NOTE

Raise or lower hoist and sling as required during steps 2 through 4 to provide work room when removing wear pad assemblies.

- 2. REMOVE TWO UPPER WEAR PAD ASSEMBLIES PARTS 3-4) FROM FRONT OF OUTER BOOM (2).
  - a. Remove capscrews (5), lockwashers (6), and flatwashers (7). Discard lockwashers (6).
  - b. Remove wear pads (3), and wear pad inserts (4).
- 3. REMOVE TWO SIDE WEAR PAD ASSEMBLIES (PARTS 8-11), FROM FRONT OF OUTER BOOM (2).
  - a. Remove capscrews (12), lockwashers (13), and flatwashers (14). Discard lockwashers (13).





### 16-12.2. INTERMEDIATE BOOM - REPLACE/REPAIR (Cont'd)

### **NOTE**

Shims (9 and 10) are used as required. Note location and quantity of shims (9 and 10) as removed.

- b. Remove wear pads (8), shims (9 and 10), and wear pad inserts(11).
- 4. REMOVE TOW LOWER WEAR PAD ASSEMBLIES PARTS 15 THROUGH 19) FROM FRONT OF OUTER BOOM (2).
  - a. Remove capscrews (20), lockwashers (21), and flatwashers (22). Discard lockwashers (21).

### NOTE

Shims (17 and 18) are used as required. Note location and quantity of shims (17 and 18) as removed.

b. Remove wear pads (15), spacer plates (16), shims (17 and 18) and wear pad inserts (19).

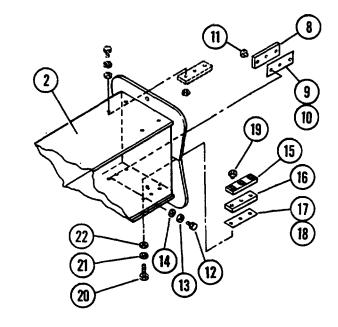
### NOTE

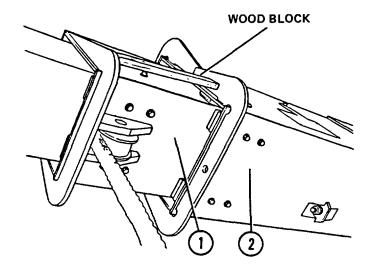
Center of gravity for intermediate boom (1) is approximately 82 inches from front flange of boom. Position hoist at center of gravity during step 5.

- 5. PLACE A SPREADER BAR UNDER INTERMEDIATE BOOM (1) AND HOLD IN PLACE. ATTACH HOIST WITH SLINGS AROUND SPREADER BAR AND INTERMEDIATE BOOM (1).
- 6. USE HOIST OT REMOVE INTERMEDIATE BOOM (1) FROM OUTER BOOM (2). PLACE INTERMEDIATE BOOM (1) ON SUPPORTS.

### DISSASSEMBLY

 REMOVE BOOM RETRACT CHAIN SHEAVE, TM10-3930-660-20, IF NECESSARY.





### 16-12.2. INTERMEDIATE BOOM - REPLACE/REPAIR (Cont'd)

- 2. REMOVE BOOM NOSE PULLEY, TM10-3930-660-20, IF NECESSARY.
- 3 REMOVE WEAR PADS, PARA. 16-14 FROM TERMEDIATE BOOM (1), IF NECESSARY.

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### INSPECTION

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

- IF REMOVAL WAS NECESSARY, INSTALL WEAR-PADS, PARA. 16-14 INSIDE INTERMEDIATE BOOM (1).
- IF REMOVAL WAS NECESSARY, INSTALL BOOM HOSE PULLEY RETRACT CHAIN SHEAVE, TM10-3930-660-20.
- 3. IF REMOVAL WAS NECESSARY, INSTALL BOOM RETRACT CHAIN SHEAVE, TM10-3930-660-20.

### **INSTALLATION**

1 INSTALL INTERMEDIATE BOOM (1).

#### NOTE

Center of gravity for intermediate boom is approximately 82 inches from front flange of boom (1). Position hoist at center of gravity.

- Place a spreader bar under intermediate boom (1) Hold reader bar in place until hoist with slings is installed.
- b. Use hoist or other suitable lifting device to install intermediate boom (1) into outer boom (2). Slide the intermediate boom (1) ¼ of the way into outer boom (2).

### 16-12.2. INTERNEDIATE BOOK - REPLACE/REPAIR (Cont'd)

 Move hoist with slings to the front end of intermediate boom (1).

### **NOTE**

All used wear pads installed in steps 2 through 4 must be at least 3/8 inch thick. If wear pad is worn to less than 3/8 inch thick, discard old wear pad and replace with new wear pad.

### NOTE

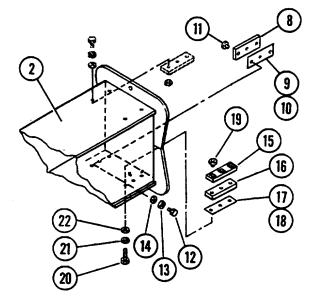
Adjust hoist and sling as required during steps 2, 3, and 4 to provide work room when installing wear pad assemblies.

 INSTALL TWO LOWER WEAR PAD ASSEMBLIES (PARTS 15-19) AT FRONT OF OUTER BOOM (2).

### **NOTE**

Shims (17 and 18) are used as required. Install same quantity of shims (17 and 18) as noted during removal.

- a. Position shims (17 and 18), spacers plates (16), wear pads (15), and wear pad inserts (19) between intermediate boom (1) and outer boom (2). Chamfered side of wear pad (15) must be facing towards intermediate boom (1). Widest portion of wear pad (15) must be facing towards outside of outer boom (2).
- Apply Loctite 242 to capscrews (20). Secure wear pad assemblies (parts 15-19) to outer boom (2) with flatwashers (22), new lockwashers (21), and capscrews (20). Torque capscrews (20) to 30 lb. ft.
- 3. INSTALL TWO SIDE WEAR PAD ASSEMBLIES (PARTS 8-11) AT FRONT OF OUTER BOOM (2).

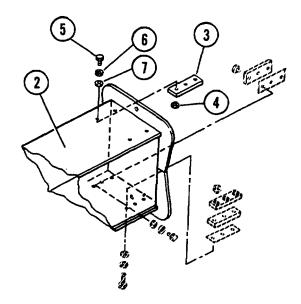


### 16-12.2. INTERMEDIATE BOOK - REPLACE/BEPAIR (Cont'd)

#### NOTE

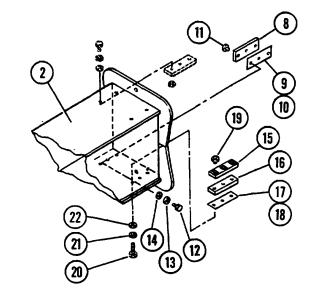
Shims (9 and 10) are used as required. Install same quantity of shims (9 and 10) as noted during removal.

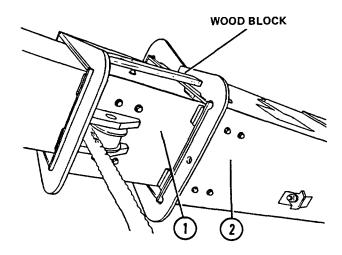
- a. Position wear pads (8), shims (9 and 10), and wear pad inserts (11), between outer boom (2)., and intermediate boom (1). Chamfered side of wear pad (8) must be facing towards intermediate boom (1). Widest portion of wear pad (8) must be facing towards bottom of outer boom (2).
- b. Apply Loctite 242 to capscrews (12). Secure wear pad assemblies (parts 8-11) to outer boom (2) with flatwashers (14), new lockwashers (13), and capscrews (12). Torque capscrews (12) to 30 lb. ft.
- 4. INSTALL TWO UPPER WEAR PAD ASSEMBLIES (PARTS 3-4) AT FRONT OF OUTER BOOM (2).
  - a. Position wear pads (3) and wear pad inserts (4) between outer boom (2) and intermediate boom (1). Chamfered side of wear pad (3) must be facing towards intermediate boom (1). Widest portion of wear pad (3) must be facing towards outside of outer boom (2).
  - b. Apply Loctite 242 to capscrews (5). Secure wear pad assemblies (parts 3-4) with flatwashers (7), new lockwashers (6), and capscrews (5). Torque capscrews (5) to 30 lb. ft.



# 16-12.2. INTERWEBDIATE BOOM - REPLACE/REPAIR (Cont'd)

- 5. USING HOIST AND SLING TO MOVE INNER BOOM, CHECK FOR CLEARANCE OF 0.01 TO 0.13 INCH BETWEEN INTERMEDIATE BOOM SURFACE AND WEAR PADS. IF NECESSARY, ADD OR SUBTRACT SHIMS (9, 10, 17, AND 18) UNTIL CLEARANCE IS WITHIN SPECIFICATIONS.
- 6 SLIDE INTERMEDIATE BOOM (1) INTO OUTER BOOM (2).
  - a. Use hoist to slide intermediate boom (1) in until it is approximately 1 foot from end of outer boom (2).
  - Install a 1 foot wood block between outer boom (2) and intermediate boom (1) for use during installation of inner boom.
- 7. INSTALL INNER BOOM, PARA. 16-12.1.





### 16-12.3. OUTER BOM - REPLACE/REPAIR

#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

### **Initial Setup**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Lifting Device (Capacity 2000 lb.)

Cap and Plug Set

#### **Equipment Condition**

Intermediate boom removed, para. 16-12.2.

### Materials/Parts

Anti-seize Compound (App. B, Item 3) Container Lint-Free Rags (App. B, Item 38) Locknut (11) Lockwashers (17), (21) Loctite 242 (App. B, Item 41) Wood Blocks

# Personnel Required

Two personnel

### **WARNING**

Hydraulic oil in the system can be under pressures over 3000 psi with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF and MLRS attachment on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

### **CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

### NOTE

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use container to catch any hydraulic oil that may drain from system.

### **NOTE**

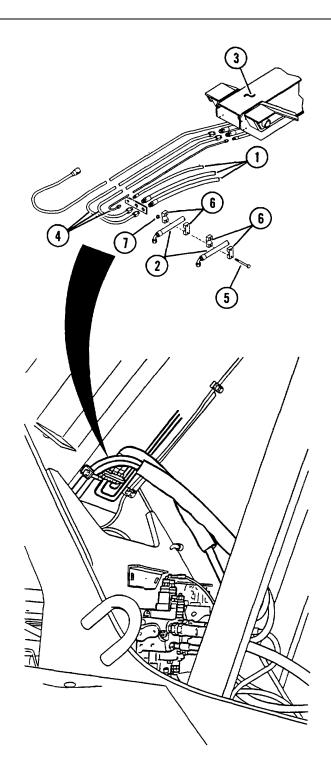
Weight of outer boom is approximately 1600 lbs.

#### **REMOVAL**

### **WARNING**

Before performing step la, make sure lines and extend cylinder hoses under boom are closed securely using metal plugs. Hydraulic oil under pressure can spray from hoses and lines causing bodily injury if lines and hoses are not closed securely.

1. DISCONECT HOSES (1 and 2) FROM UNDERSIDE OF OUTER BOOM (3).

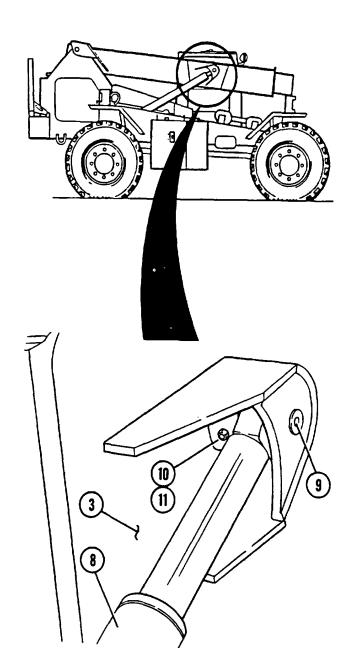


 Start engine and raise outer boom (3) as necessary to access hoses (1 and 2). Stop engine.

### **WARNING**

Disconnect hoses carefully during step b. Hydraulic oil may be under pressure. Failure to follow this precaution will cause personal injury.

- to the bound of the bou
- Remove capscrew (5), four clamp halves (6) and nut (7) securing two hoses (2). Leave hoses (2) plugged with metal caps.
- 2. DISCONNECT ROD END OF BOTH BOOM HOIST CYLINDERS (8) FROM OUTER BOOM (4).
  - Place suitable wood block across vehicle deck behind cab to support boom hoist cylinders (8) when cylinders are lowered.
  - b. Start engine. Lower outer boom until cylinder pivot pins (9) are just above cab. Stop engine.
  - c. Support outer boom (3) with hoist and slings positioned at front of boom (3).
  - Remove capscrew (10) and locknut (11) securing pivot pin (9) to boom hoist cylinder (8). Discard locknut (11).
  - e. Support boom hoist cylinder (8). Remove pivot pin (9) from outer boom (3) and boom hoist cylinder (8).



#### NOTE

In step 2f, release hydraulic joystick immediately after boom hoist cylinder (8) being removed has fully retracted. If joystick is allowed to remain open, the other cylinder (8) will start to retract, putting extreme stress on lifting equipment and boom.

- f. Start engine and run at full throttle. Fully retract boom hoist cylinder (8). Cylinder (8) will retract very slowly. Stop engine.
- g. Carefully lower cylinder (8) onto board placed across vehicle deck so hydraulic line on cylinder (7) is not damaged.
- h. Repeat steps 2d through 2g for other cylinder (8).
- 3. PLACE JACKSTAND OR SUPPORT ON FRONT OF VEHICLE DECK. ADJUST SUPPORT SO THAT OUTER BOOM (3) WILL BE LEVEL WHEN LOWERED.
- 4. CAREFULLY LOWER OUTER BOOM (3) WITH HOIST AND SLING UNTIL FRONT OF BOOM (3) IS ON JACKSTAND OR SUPPORT.
- 5. REMOVE OUTER BOOM (3) FROM VEHICLE FRAME.

#### **NOTE**

Center of gravity for outer boom (4) is approximately 92.5 inches from front flange of outer boom (3).

### **CAUTION**

To prevent damage to lines (4) during step 5a, place wood boards between underside of outer boom (3) and slings.

- a. Reposition hoist and slings to center of gravity for outer boom (3). Carefully raise outer boom (3) until weight of boom is removed from boom pivot pins (12).
- b. Remove capscrew (13) and locknut (14) securing boom pivot pin (12) to vehicle frame. Discard locknut (14).

#### NOTE

Shims (15) may fall out as pivot pins (12) are removed.

- c. Remove boom pivot pin (12) from outer boom (3) and vehicle frame.
- Remove shims (15) from between outer boom
   (3) and vehicle frame. Note quantity and position of shims (15) for use during installation.
- e. Repeat steps 5b through 5d for other boom pivot pin (12).

### **CAUTION**

Be careful that lines (4) on underside of outer boom (3) are not damaged when boom (3) is lowered onto supports.

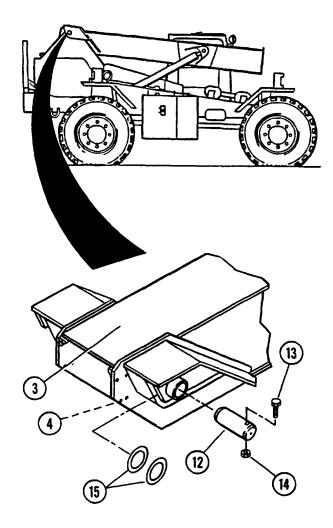
f. Carefully remove outer boom (3) from vehicle and lower boom (3) onto supports.

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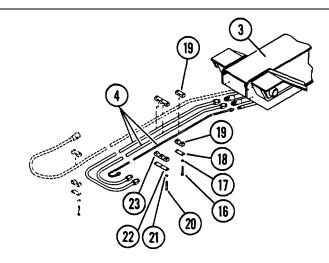
#### **SASSEMBLY**

IF NECESSARY, REMOVE THREE LINES (4) FROM UNDERSIDE OF OUTER BOOM (3).

Lines (4) are not interchangeable. Note location of each line (5) for use during installation.



- Remove two capscrews (16), two lockwashers (17), and one clamp cover (18) from each pair of clamp halves (19). Discard lockwashers (17). Note location and orientation of clamp halves (19) for use during installation.
- Remove three capscrews (20), three lockwashers (21), and one clamp cover (22), from each pair of clamp halves (23). Discard lockwasher (21). Note location and orientation of clamp halves (23) for use during installation.
- c. Remove three lines (4) from underside of outer boom (3).



#### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

### **ASSEMBLY**

IF NECESSARY, INSTALL THREE LINES (4) TO UNDERSIDE OF OUTER BOOM (3).

#### NOTE

Lines (4) are not interchangeable. Install lines (4) in locations noted during removal.

a. Position three lines (4) on underside of outer boom (3).

### **NOTE**

Apply Loctite 242 to capscrews (20) and (16) as installed.

 Install one clamp cover (22), three new lockwashers (21), and three capscrews (20) to each pair of clamp halves (23). Ensure that clamp halves (23) are positioned as noted during disassembly.

c. Install one clamp cover (18), two new lockwashers (17), and two capscrews (16) to each pair of clamp halves (19). Ensure that clamp halves (19) are positioned as noted during disassembly.

### **INSTALLATION**

#### NOTE

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on hydraulic components and hoses clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

1. INSTALL OUTER BOOM (3) TO VEHICLE FRAME.

### **NOTE**

Center of gravity for outer boom (3) is approximately 92.5 inches from front flange of boom (3).

### **CAUTION**

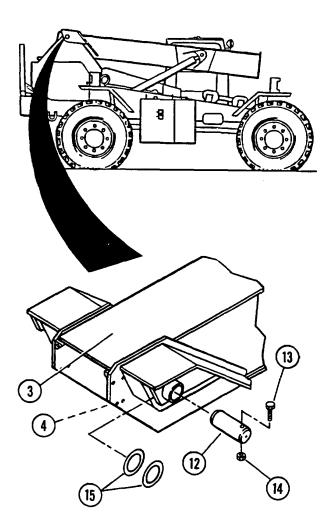
To prevent damage to steel tubes (4) during step la, place wood boards between underside of outer boom (3) and slings.

a. Carefully lift outer boom (3) into position over vehicle with hoist and sling. Lower boom (3) as required to align boom pivot pin holes.

### N OTE

Apply anti-seize compound to pivot pin (12) as installed.

- Position shims (15) between outer boom (3) and inside surface of vehicle frame. Install boom pivot pin (12).
- c. Secure boom pivot pin (12) to vehicle frame with capscrew (13) and new locknut (14).



- d .Repeat steps 1b and 1c for other pivot pin.
- 2. PLACE JACKSTAND OR SUPPORT ON FRONT OF VEHICLE DECK. ADJUST SUPPORT SO OUTER BOOM (3) IS LEVEL WHEN LOWERED.
- 3. CAREFULLY LOWER OUTER BOOM (3) WITH HOIST AND SLING UNTIL FRONT OF BOOM (3) IS RESTING ON SUPPORT.
- 4. CONNECT ROD ENDS OF BOOM HOIST CYLINDERS (8) TO OUTER BOOM (3).
  - a. Reposition slings to front of outer boom (3).
  - b. Lift outer boom (3) until cylinder pivot pin holes of boom (3) are just above cab.
  - c. Lift and support boom hoist cylinders (8).

#### NOTE

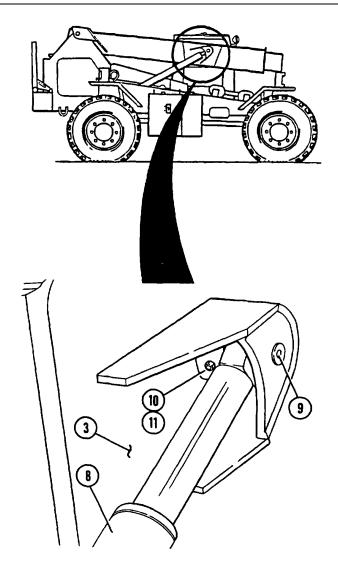
One boom hoist cylinder (8) will begin to extend before the other. Install this cylinder (8) first. Second cylinder (8) will begin to extend after first cylinder (8) is connected.

 Start engine. Use joystick to extend boom hoist cylinder (8) until cylinder rod eye is aligned with pivot pin hole of boom. Stop engine.

### **NOTE**

Apply anti-seize compound to pivot pin (9) as installed.

- e. Install pivot pin (9).
- f. Secure pivot pin (9) to outer boom (3) with capscrew (10) and new locknut (11).
- g. Repeat steps 4d through 4f for other boom hoist cylinder (8).

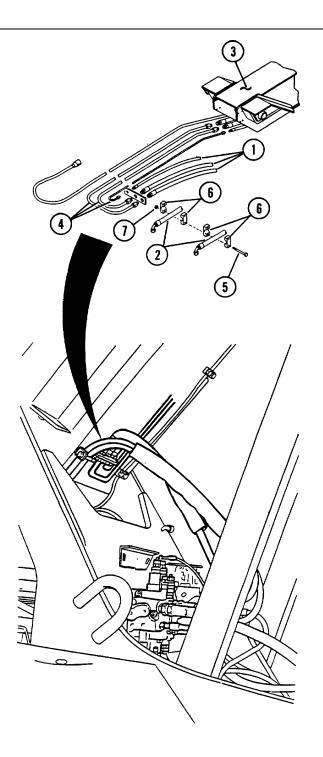


- 3. CONNECT HOSES (1 and 2) TO UNDERSIDE OF OUTER BOOM (3).
  - a. Start engine and raise outer boom (3) as required for access to lines (4). Stop engine.

### **WARNING**

Remove hose caps carefully prior to connecting lines (4) in step 3b. Hydraulic oil may be under pressure. Failure to follow this precaution will cause personal injury.

- b. Connect three hoses (1) to three lines (4) at bulkhead as tagged.
- c. Position hoses (2) on underside of outer boom (3) and secure with four clamp halves (6), nut (7) and capscrew (5).
- 4. START ENGINE AND LOWER OUTER BOOM (3) UNTIL HORIZONTAL. STOP ENGINE.
- 5. INSTALL INTERMEDIATE BOOM, PARA. 16-12.2.
- 6. LUBRICATE BOOM PIVOT PINS AND BOOM HOIST CYLINDER UPPER PIVOT PINS, LO10-3930-660-12.



### 16-13. BOOM PIVOT PIN - REPLACE

#### This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

### **Initial Setup**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Lifting Device (Capacity 5 ton)

### **Equipment Condition**

Vehicle parked on level ground. Boom retracted and level. Forks leveled and resting on ground.

#### Materials/Parts

Anti-seize Compound (App. B, Item 3) Grease (App. B, Item 11) Locknut (2)

### **REMOVAL**

### **NOTE**

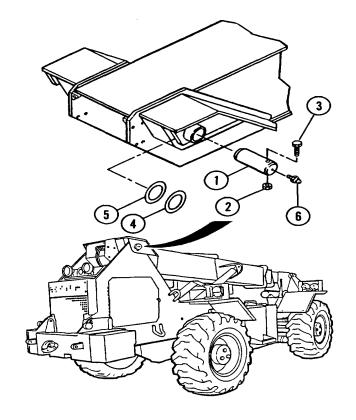
The procedures to remove left and right boom pivot pins are the same.

- 1. USE A HOIST OR OTHER SUITABLE LIFTING DEVICE TO SUPPORT BACK OF BOOM AND TAKE WEIGHT OF BOOM OFF PIVOT PINS (1).
- 2. REMOVE LOCKNUT (2) AND HEX HEAD CAPSCREW (3). DISCARD LOCKNUT (2).

### **NOTE**

The boom has washer spacers between boom and frame. Note position and quantity of washer spacers for assembly.

- 3. USE A SLIDE HAMMER OR PULLER TO REMOVE PIVOT PIN (1) AND ANY WASHER SPACERS (4 OR 5).
- 4. REMOVE GREASE FITTING (6), IF NECESSARY.



### 16-13. BOOM PIVOT PIN - RKEPLACE (Cont'd)

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

### **INSTALLATION**

### **NOTE**

The procedures to install left and right boom pivots are the same.

1. IF REMOVAL WAS NECESSARY, INSTALL GREASE FITTING (6).

### **NOTE**

Apply anti-seize compound to pivot pin (1) as installed.

- 2. INSTALL PIVOT PIN (1) AND ANY WASHER SPACERS (4 OR 5).
- 3. INSTALL HEX HEAD CAPSCREW (3) AND NEW LOCKNUT (2).
- 4. APPLY GREASE TO FITTING (6).

16-90

#### 16-14. WEAR PADS - REPLACE

This task covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

### **Initial Setup**

<u>Tools</u>

Tool Kit, Automotive,

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Tool Kit, Body and Fender Repair

**Equipment Condition** 

Vehicle parked on level ground.

Boom retracted.

### Materials/Parts

Mechanics Inserts (4) Lockwashers (2) Loctite #242 (App. B, Item 41)

### **REMOVAL**

### **NOTE**

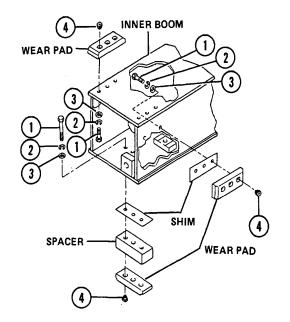
The amount of boom disassembly will depend upon location of wear pads being replaced.

1. DISASSEMBLE INNER AND INTERMEDIATE BOOMS AS NECESSARY FOR WEAR PAD REPLACEMENT, PARAS. 16-12.1 AND 16-12.2.

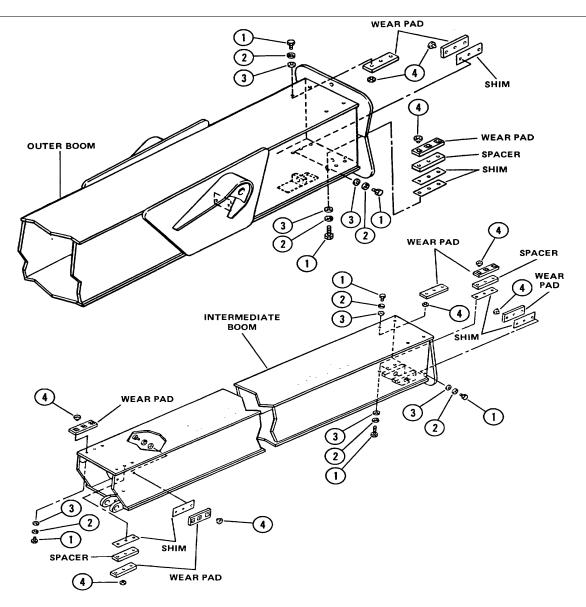
### **NOTE**

Most wear pads have off-center mounting holes. Note orientation of wear pads prior to removal.

- 2. REMOVE WEAR PAD WHICH NEEDS REPLACEMENT.
  - Remove capscrews (1), lockwashers (2), flatwashers (3) and wear pads. Some pads have spacers and shims. Note quantity and locations of these items before removal. Discard lockwashers (2).



# 16-14. WEAR PADS - REPLACE (Cont'd)



16-92

# 16-14. WEAR PADS - REPLACE (Cont'd)

b. Remove and discard inserts (4) with worn wear pad(s).

# **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

### **INSTALLATION**

- 1. INSTALL WEAR PAD(S).
  - a. Install new inserts (4) in wear pads.
  - b. Apply Loctite %242 on threads of capscrews (1).
  - c. Install capscrews (1), new lockwashers (2), flatwashers (3), shims, spacers and wear pads. Torque capscrews to 30 lb. ft.

### **NOTE**

Check for proper clearances between wear pads and boom sections during assembly. A total gap of 0.01 to 0.13 inch is allowed in both vertical and horizontal directions.

2. ASSEMBLE INNER AND INTERMEDIATE BOOMS AS NECESSARY, PARAS. 16-12.1 AND 16-12.2.

### 16-15. EXTEND AND RETRACT CHAINS - REPLACE

### This task covers:

- a. Extend Chain Removal
- b. Retract Chain Removal
- c. Extend Chain Installation
- d. Retract Chain Installation

# **Initial Setup**

Tools

Tool Kit, Automotive Mechanics

Materials/Parts

Cotter Pin (15) Lockwashers (2)

Loctite #242 (App. B, Item 41)

Rope

**Equipment Condition** 

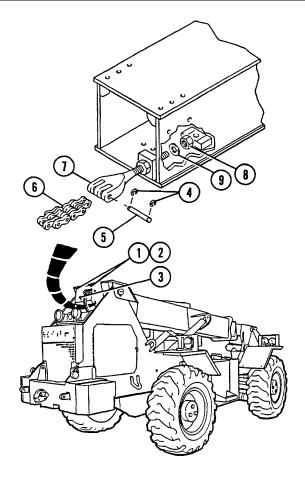
Vehicle parked on level ground. Boom retracted.

#### **NOTE**

For retract chain, inner boom must be removed.

### **EXTEND CHAIN REMOVAL**

- 1. REMOVE PARTS (1-6 and 8-11).
  - Remove four hex head capscrews (1), four lockwashers (2) and cover (3). Discard lockwashers (2).
  - b. Remove two retaining rings (4) and one pin (5). Disconnect extend chain (6) from clevis (7).
  - c. If clevis (7) is damaged, remove nut (8), flatwasher (9) and clevis (7).
  - Remove nut (10) and flatwasher (11) from clevis (12). Remove clevis (12) from its mounting hole near hose tensioner.



# 16-15. EXTEND AND RETRACT CHAINS - REPLAC (Cont'd)

- 2. REMOVE EXTEND CHAIN (6).
  - a. Tie a rope of suitable length to end of extend chain (6), just behind clevis (12).
  - Tie other end of rope to clevis (12) mounting hole.

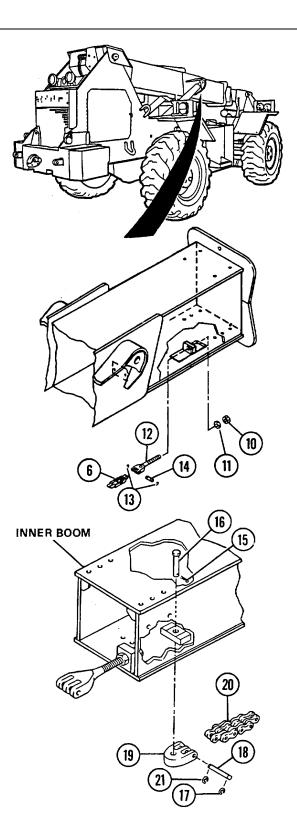
#### NOTE

Leave rope inside boom after removing extend chain (6). The rope will be used to pull new extend chain (6) through boom assembly.

- c. Pull extend chain (6) out from back of boom. Remove rope from chain (6).
- d. Remove two retaining rings (13), pin (14) and clevis (12). Separate extend chain (6) from clevis (12).

### **RETRACT CRAIN REMOVAL**

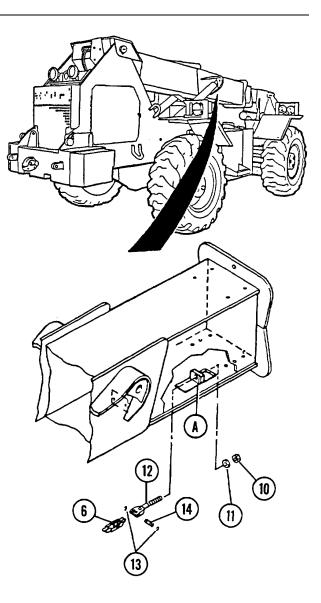
- 1. REMOVE INNER BOOM, PARA. 16-12.1.
- 2. REMOVE COTTER PIN (15) AND CLEVIS PIN (16). DISCARD COTTER PIN (15).
- 3. REMOVE RETAINING RING (17), PIN (18), CLEVIS (19) TO DISCONNECT RETRACT CHAIN (20). REMOVE RETAINING RING (21) FROM PIN (18), IF NECESSARY.



# 16-15. EXTEND AND RETRACT CHAINS - REPLACE (Cont'd

### **EXTEND CHAIN INSTALLATION**

- 1. INSTALL EXTEND CHAIN (6).
  - a. Attach one end of extend chain (6) to clevis (12). Install pin (14) and two retaining rings (13).
  - b. Tie rope (that was used during removal and found inside boom) to end of extend chain (6) just behind clevis (12).
  - c. Pull rope with extend chain (6) through boom. Pull rope through opening (A) in boom near clevis (12) mounting hole. Remove rope from clevis (12) mounting hole and end of extend chain (6).
  - d. Install clevis (12) with extend chain (6) into mounting hole. Secure with flatwasher (11) and nut (10).
  - e. If removal was necessary, install clevis (7), flatwasher (9) and nut (8).

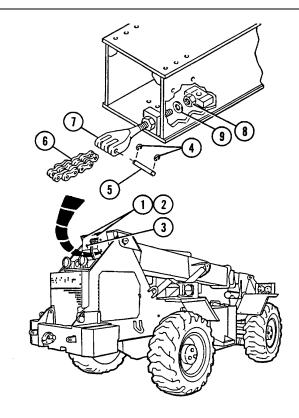


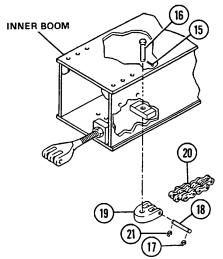
## 16-15. EXTE AND RETRACT CHAINS - REPLACE (Cont'd)

- f. Attach extend chain (6) end to clevis (7). Install pin (5) and two retaining rings (4).
- g. Install cover (3), four new lockwashers (2) and four hex head capscrews (1).
- 2. ADJUST EXTEND CHAIN (6), TM10-3930-660-20.
- 3. ADJUST HOSE AND CABLE TENSION, TM10-3930-660-20.

### **RETRACT CHAIN INSTALLATION**

- 1. POSITION CLEVIS (19) ON END OF RETRACT CHAIN (20). INSTALL PIN (18) AND RETAINING RING (17).
- 2. IF REMOVAL WAS NECESSARY, INSTALL RETAINING RING (21) ON PIN (18).
- 3. INSTALL CLEVIS PIN (16) THRU CLEVIS (19) AND SECURE WITH NEW COTTER PIN (15).
- 4. INSTALL INNER BOOM, PARA 16-12.1.
- 5. ADJUST RETRACT CHAIN, TM10-3930-660-20.





#### This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning
- d. Inspection
- e. Assembly
- f. Installation

### **Initial Setup**

## Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and

Attachment Hoist;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Gland;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Piston;

Spanner Wrench, Boom Lift Cylinder

and Boom Extend Cylinder

Lifting Device (Capacity 500 lb.)

### **Equipment Condition**

Vehicle parked on level ground.

Boom retracted.

### Materials/Parts

Anti-seize Compound (App. B, Item 3)

Container

Dry Cleaning Solvent P-D-680 (App. B,

Item 47)

Hydraulic Oil (App. B, Item 35)

Lint-Free Rags (App. B, Item 38)

Locknuts (16)

Lockwashers (2)

Loctite #242 (App. B, Item 41)

Loctite #271 (App. B, Item 43)

Nut (48)

O-rings (32, 33, 34, 38, 39, 40, 45,

50, 52)

Seal (47)

Tags (App. B, Item 52)

Wood Blocks

### Personnel Required

2 Personnel

# **REMOVAL**

### WARNING

Hydraulic oil in the system can be under pressure over 5, 000 psi with the engine and pump OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With the engine OFF and hydraulic attachments on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

#### CAUTION

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

#### NOTE

If more than one hydraulic line is removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

## **CAUTION**

Retract cylinder before removal. Failure to follow this precaution will cause part damage.

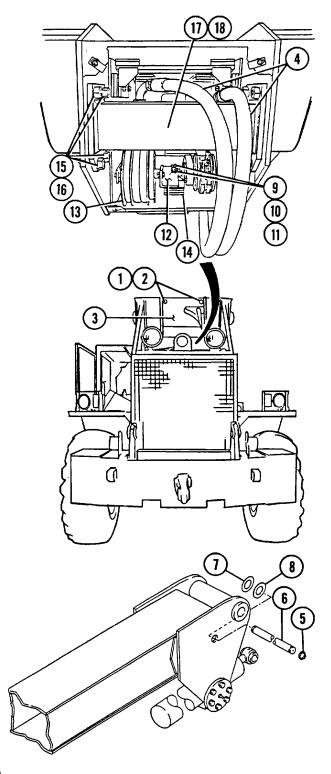
- 1. DISCONNECT HOSES (4).
  - a. Remove four hex head capscrews (1), four lockwashers (2) and cover (3). Discard lockwashers (2).
  - b. Disconnect two hoses (4).
- 2. REMOVE PARTS (5-26).
  - a. Remove snap ring (5), shaft (6), spacer (7) and two spacers (8).
  - Remove two hex head capscrews (9), two lockwashers (10), two flatwashers (11) and bracket (12) with pulley (13). Re-install capscrews (9), lockwashers (10) and flatwashers (11) to secure boom wear pad (14) in place.
  - Place wood blocks underneath boom extend cylinder and inner boom.
  - Remove eight hex head capscrews (15) and eight locknuts (16) from extend cylinder anchor (17). Discard locknuts (16).

#### NOTE

Raise cylinder as needed with hoist and sling during removal to provide clearance over obstructions at rear of boom.

e. Use a hoist and sling to pull extend cylinder (18) out, with extend cylinder anchor (17).

Reposition hoist and sling as needed during removal of cylinder (18).

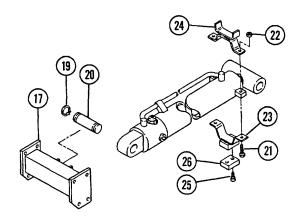


f. Remove extend cylinder (18) with extend cylinder anchor (17) as a unit.

### **CAUTION**

Remove cylinder from sling with care to prevent part damage.

- g. Remove two snap rings (19), one shaft (20) and extend cylinder anchor (17).
- h. Remove two hex head capscrews (21), two nuts (22) and two buckling braces (23 and 24).
- i. Remove two socket head capscrews (25) and wear pad (26).



# **DISASSEMBLY**

 USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.

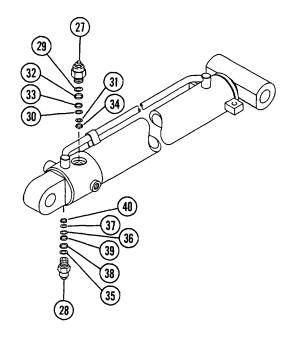
### WARNING

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (27) or (28) and allow pressure to escape before removing valve entirely.

2. REMOVE TWO COUNTERBALANCE VALVES (27 AND 28).

### **NOTE**

Note and mark location of counterbalance valves (27 and 28) for use during assembly. The valves (27 and 28) are not interchangeable.



- a. Remove backup rings (29 and 30), two backup rings (31), and three O-rings (32-34) from each counterbalance valve (27). Discard O-rings (32-34).
- b. Remove three backup rings (35-37) and three O-rings (38-40) from counterbalance valve (28). Discard O-rings (38-40).
- 3. DISASSEMBLE CYLINDER PARTS (41-55).
  - a. Remove needle valve (41).

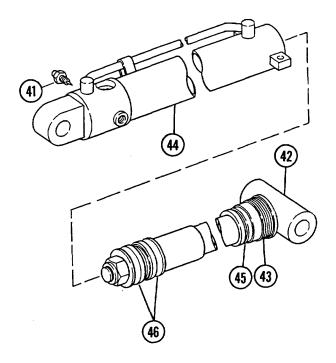
# **CAUTION**

Do not scratch or damage the wear surface of rod (42), piston or gland (43).

- b. Pull rod (42) out approximately 5 inches for removal of gland (43).
- c. Place a container under gland (43) to catch oil contained in cylinder.
- d. Use a spanner wrench to remove gland (43) from barrel (44). Pull gland (43) out of cylinder far enough to unseat O-ring (45).
   Allow oil to drain into container.

## **CAUTION**

Use care when removing rod (42) and piston assembly to prevent wear ring (46) damage. Keep rod (42) in line with cylinder tube to prevent binding.



- e. Remove rod (42) and piston assembly from barrel (44).
- f. Place rod (42) and piston assembly on suitable supports to prevent damage.
- g. Remove two wear rings (46).

### **CAUTION**

Do not nick or scratch seal groove on piston (49) during removal of seal (47). Failure to follow this precaution will cause part damage.

h. Cut seal (47) and discard.

### **NOTE**

The nut (48) may need to be heated with a torch for removal.

- i. Remove nut (48) and piston (49). Discard nut (48).
- j. Remove and discard O-ring (50) from piston (49) bore
- k. Remove tube (51) and gland (43) off rod (42).
- I. Remove O-rings (45 and 52) and backup ring (53) from gland (43). Discard O-rings (45 and 52).

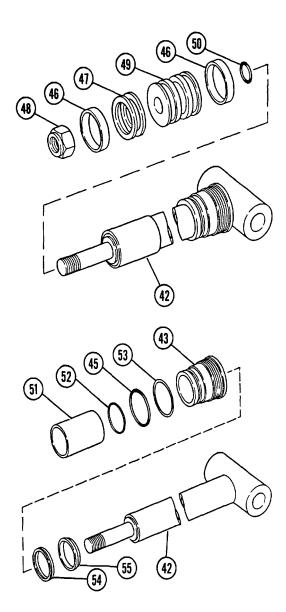
### **CAUTION**

Do not nick or scratch seal groove inside gland (43) during removal of seal (54) and rod wiper (55). Failure to follow this precaution will cause part damage.

#### **NOTE**

Note direction that lip of seal (54) is facing before removal.

m. Remove seal (54) and rod wiper (55) from inside of gland (43).



### **CLEANING**

See Cleaning Instructions, para. 2-10.

#### **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

### **NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

#### **NOTE**

When installing rod (42) and nut (48), apply Loctite #271 on threads.

- 1. ASSEMBLE CYLINDER PARTS (41-55).
  - a. Install seal (54) and rod wiper (55) inside gland (43).
  - b. Install backup ring (53) and new O-rings (45 and 52) on outside diameter of gland (43).
  - c. Slide gland (43) and tube (51) onto rod (42).
  - d. Lubricate piston (49) inner diameter with clean hydraulic oil. Install new O-ring (50) inside bore of piston (49).
  - e. Use a cleaning solvent and lint- free rag to clean threads on rod (42) and new nut (48).
  - f. Slide piston (49) onto rod (42).

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- g. Apply Loctite #271 on threads of rod (42) and nut (48). Install nut (48) on rod (42).
- h. Place rod (42) and piston (49) assembly on suitable supports to prevent damage during assembly.
- Install two wear rings (46) and one new seal (47) on piston (49). Position wear rings so that gaps are 180 degrees apart.

### **CAUTION**

Use care when installing rod (42) and piston (49) assembly. Keep rod (42) in line with barrel (44) to prevent binding. Failure to follow this precaution will cause part damage.

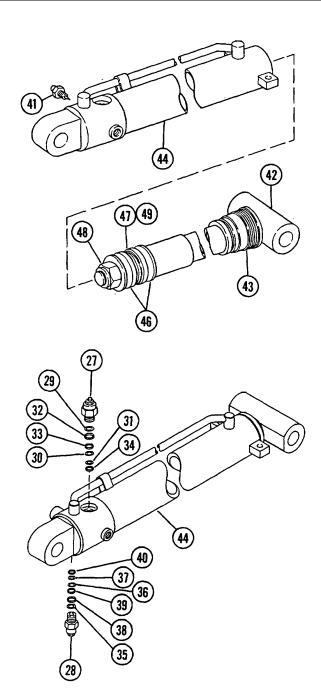
- Lubricate barrel (44) inner diameter, piston (49) outside diameter and gland (43) outside diameter with clean hydraulic oil.
- k. Position rod (42) and piston (49) assembly in barrel (44).

### **NOTE**

Tighten gland (43) so that it is flush with end of barrel (44). Do not overtighten gland (43).

- I. Tighten gland (43) on barrel (44).
- m. Install needle valve (41).
- 2. INSTALL COUNTERBALANCE VALVES (27 AND 28).
  - a. Install three new O-rings (38-40) and three backup rings (35-37) on counterbalance valve (28).
  - b. Install backup rings (29 and 30), two backup rings (31) and three new O-rings (32, 33 and 34) on counterbalance valve (27).

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 Install two assembled counterbalance valves (27 and 28) in cylinder tube (44) as noted during disassembly.

### **INSTALLATION**

### **NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on valve and hoses clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

1. INSTALL PARTS (5-8 AND 15-26).

### NOTE

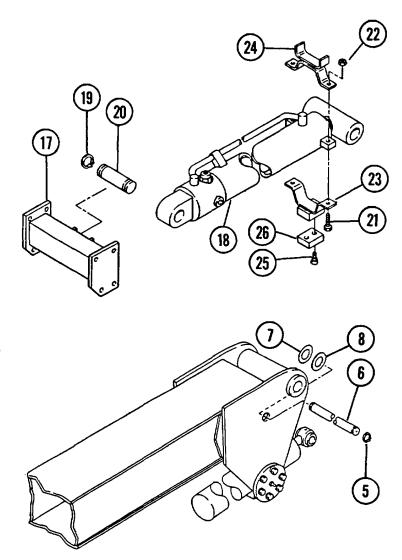
Apply anti-seize compound to shaft (20) as installed.

- a. Install shaft (20), two snap rings (19) and extend cylinder anchor (17).
- b. Install wear pad (26) and two socket head capscrews (25).
- c. Install two buckling braces (23 and 24), two hex head capscrews (21) and two nuts (22).
- d. Use a sling and hoist to install extend cylinder (18) at back of boom.
- e. Have an assistant guide extend cylinder (18) and slide it into boom.

# **NOTE**

Apply anti-seize compound to shaft (6) as installed.

- f. Install two spacers (8), one spacer (7), shaft (6) and snap ring (5).
- g. Place wood blocks underneath boom extend cylinder and inner boom.



- h. Remove hoist and sling from back of extend cylinder.
- Install eight hex head capscrews (15) and eight locknuts (16) to secure extend cylinder anchor (17).

### **NOTE**

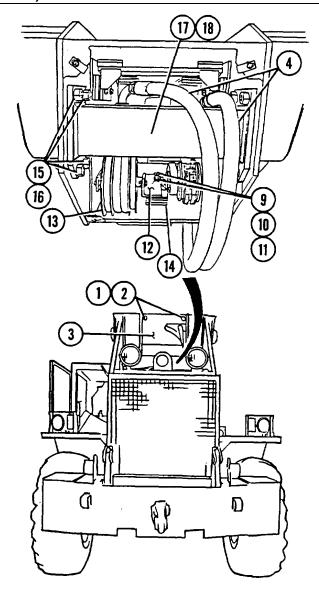
Attach a hoist with sling at front of inner boom if mounting holes between outer boom and extend cylinder anchor do not align. Move inner boom as needed to align mounting holes.

j. Remove wood blocks underneath boom extend cylinder and inner boom.

### **NOTE**

When installing capscrews (9), apply Loctite #242 on threads.

- 2. CONNECT HOSES (4) AND INSTALL COVER (3).
  - a. Connect two hoses (4) to extend cylinder.
  - b. Install pulley (13) with bracket (12).
  - c. Remove two hex head capscrews (9) two flatwashers (11) and two new lockwashers (10) that held boom wear pad (14) in place.
  - d. Apply Loctite #242 on threads of capscrews (9) and re-install them and flatwashers (11) to secure bracket (12).
  - e. Adjust hose and cable tension, TM10-3930-660-20.
  - f. Install cover (3), four new lockwashers (2) and four hex head capscrews (1).



### 16-17. FORK SIDESHIFT CYLINDERS - REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

## **Initial Setup**

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common #2 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and Attachment Hoist; Spanner Wrench, Fork Sideshift Cylinder - Outer Gland; Spanner Wrench, Fork Sideshift Cylinder - Outer Piston; Spanner Wrench, Boom Lift Cylinder and Boom Extend Cylinder. Wrench, Strap, 1-6 inch Capacity

# **Equipment Condition**

Fork sideshift cylinder removed, TM10-3930-660-20.

Materials/Parts

Container
Hydraulic Oil (App. B, Item 35)
Lint-Free Rags (App. B, Item 38)
O-rings (10, 16)
Seal (15)

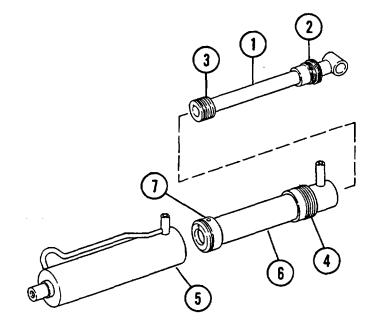
## **DISASSEMBLY**

- USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.
- 2. DISASSEMBLE CYLINDER PARTS (1-19).

### **CAUTION**

Do not scratch or damage the wear surface of rod (1), piston or inner gland (2). Follow this precaution to prevent failure of the cylinder.

a. Use a suitable tool to pull rod(1) out approximately 5 inches for removal of inner gland (2).



### 16-17. FORK SIDRBSIFT CYLINDERS - REPAIR (Cont'd)

 Place a container under inner gland (2) to catch oil contained in cylinder.

### **CAUTION**

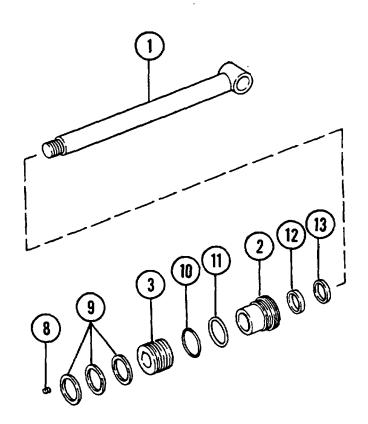
Use care when removing rod (1) and piston assembly to prevent seal damage. Keep rod (1) in line with barrel (3) to prevent binding.

- Use a spanner wrench to unscrew inner gland (2) from rod (1).
   Remove rod (1), inner gland (2) and inner piston (3) as an assembly. Clamp assembly in a holding device.
- d. Use a spanner wrench to remove outer gland (4) from barrel (5).
   Remove outer gland (4), cylinder tube (6) and outer piston (7) as an assembly.
- e. Remove setscrew (8) from inner piston (3) face.
- f. Remove three piston rings (9).
- g. Heat inner piston (3) with acetylene torch to approximately 300-400°F. Use a strap wrench to remove inner piston (3) from rod (1).
- h. Remove inner gland (2).

### **CAUTION**

Do not nick or scratch seal groove of gland (2) during removal of seal (11). Failure to follow this precaution will cause part damage.

 Remove O-ring (10) and backup ring (11) from outer diameter of inner gland (2). Discard O-ring (10).



### **NOTE**

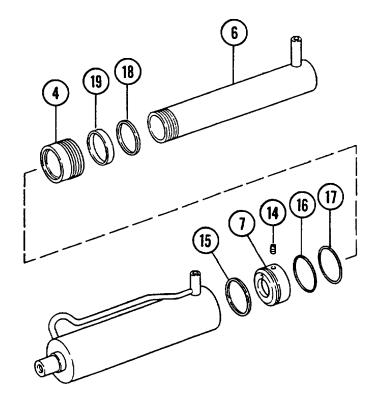
Note direction that lip of seal (12) is facing before removal.

- j. Remove seal (12) and rod wiper (13) from inner diameter of inner gland (2).
- k. Remove setscrew (14) from outer diameter of outer piston (7).
- 1. Cut seal (15) to remove it from outer piston (7).
- m. Heat outer piston (7) with acetylene torch to approximately 300-4000F. Use a spanner wrench to remove outer piston (7) from cylinder tube (6).
- n. Remove outer gland (4) from cylinder tube (6).
- Remove O-ring (16) and backup ring (17) from outer diameter of outer gland (4). Discard O-ring (16).

### **NOTE**

Note direction that seal (19) is facing before removal.

p. Remove wear ring (18) and seal (19) from inner diameter of outer gland (4).



### 16-17. FORK SIDESBIFT CYLINDBRS - REPAIR (Cont'd)

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

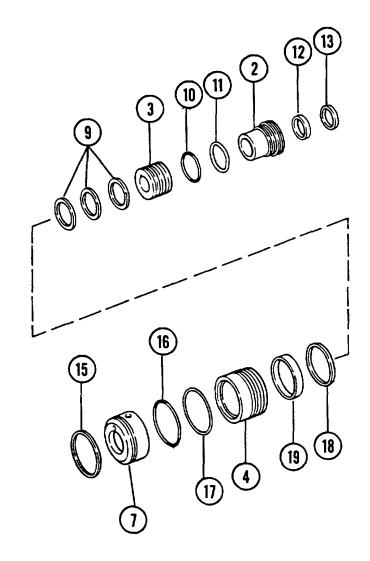
#### NOTE

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. ASSEMBLY CYLINDER PARTS (1-19).
  - a. Install seal (12) and rod wiper (13) in inner diameter of inner gland (2). Ensure that seal (12) is positioned in same direction as was noted before removal.
  - b. Install backup ring (11) and new O-ring (10) on outer diameter of inner gland (2).
  - c. Install seal (19) and wear ring (18) in inner diameter of outer gland (4). Ensure that seal (19) is positioned in same direction as noted before removal.
  - Install backup ring (17) and new
     O-ring (16) on outer diameter of outer gland (4).
  - e. Install three piston rings (9) on inner piston (3). Stagger piston gaps to provide 90 degree relationship between all gaps.

## **NOTE**

Excessive piston ring (9) bypass may occur if gaps are aligned.

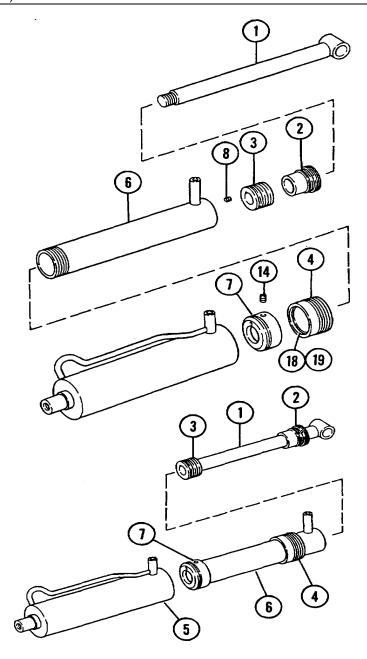


### 16-17. FORK SIDESHIFT CYLINDERS - REPAIR (Cont'd)

- f. Install new seal (15) on outer piston (7).
- g. Lubricate inner diameter of inner gland (2) and seals (12 and 13) with clean hydraulic oil. Slide inner gland (2) onto rod (1).
- h. Use solvent to clean threads of rod (1) and apply Loctite #242. Install inner piston (3) onto rod (1). Use a strap wrench to tighten piston (3) and install setscrew (8). Tighten setscrew (8) and stake.
- Lubricate inner diameter of outer gland (4) and seals (18 and 19) with clean hydraulic oil. Slide outer gland (4) onto cylinder tube (6).
- J. Use solvent to clean threads of cylinder tube (6) and apply Loctite #242. Install outer piston (7) onto cylinder tube (6) and tighten. Install setscrew (14) into outer piston (7) and tighten. Stake setscrew (14).
- k. Use solvent to clean threads of inner gland (2) and outer gland (4). Apply Loctite #242.
- Clean threads inside barrel (5). Slide outer piston (7) with cylinder (6) as an assembly, into barrel (5).
- m. Install outer gland (4) into barrel (5). Tighten outer gland (4) until it is flush with end of barrel. Do not overtighten outer gland (4).

### **CAUTION**

Use care when installing rod (1) and piston assembly. Keep rod (1) in line with barrel (5) to prevent binding.



- Slide inner piston (3) on rod (1) into barrel (5). Use a spanner wrench to tighten inner gland (2) until it is flush with end of barrel (5).
- 2. INSTALL FORK SIDESHIFT CYLINDER TM10-3930-660-20.

### 16-18. BOOM HOIST CYLINDERS - REPAIR

#### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

## **Initial Setup**

### **Tools**

Shop Equipment, Automotive Maintenance, Common 12 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and Attachment Hoist;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Gland;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Piston;

Spanner Wrench, Boom Lift Cylinder

and Boom Extend Cylinder

### **Equipment Condition**

Boom hoist cylinder removed, TM10-3930-660-20.

### Materials/Parts

Container
Dry Cleaning Solvent P-D-680 (App. B, Item 48)
Hydraulic Oil (App. B, Item 35)
Loctite #271(App. B, Item 43)
Nut (14)

O-rings (5, 6, 7, 11, 16 18) Seal (13)

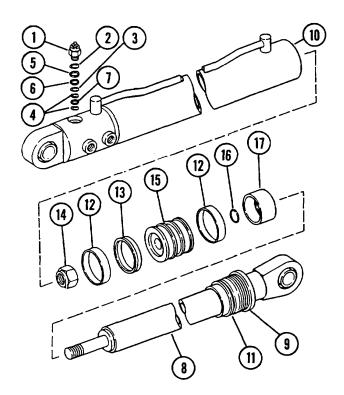
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**DISASSEMBLY** 

 USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.

### **WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (1) and allow pressure to escape before removing valve entirely.



### 16-18. BOOM HOIST CYLINDERS - REPAIR (Cont'd)

- RELIEVE PRESSURE IN CYLINDER BY SLOWLY REMOVING COUNTERBALANCE VALVE (1). DRAIN RESIDUAL OIL THROUGH VALVE HOLES INTO A SUITABLE CONTAINER.
- 3. REMOVE BACKUP RINGS (2 AND 3), TWO BACKUP RINGS (4), AND THREE O-RINGS (5, 6 AND 7) FROM EACH COUNTERBALANCE VALVE (1). DISCARD O-RINGS (5, 6 AND 7).
- 4. DISASSEMBLE CYLINDER PARTS (8-24).

#### **CAUTION**

Do not scratch or damage the wear surface of rod (8), piston or gland (9). Follow this precaution to prevent failure of the cylinder.

- a. Use a suitable tool to pull rod
  (8) out approximately 5 inches for removal of gland (9).
- Place a container under gland (9) to catch oil contained in cylinder.
- Use a spanner wrench to unscrew gland (9) from cylinder tube (10). Pull gland (9) out of cylinder far enough to unseat O-ring (11). Allow oil to drain into container.

### **CAUTION**

Use care when removing rod (8) and piston assembly to prevent wear ring (12) damage. Keep rod (8) in line with cylinder tube to prevent binding.

- d. Remove rod (8) and piston assembly from cylinder tube (10).
- e. Place rod (8) and piston assembly on suitable supports to prevent damage.

f. Remove two wear rings (12).

### **CAUTION**

Do not nick or scratch seal groove during removal of seal (13). Failure to follow this precaution will cause part damage.

g. Cut seal (13) and discard.

#### NOTE

The nut (14) may need to be heated with a torch for removal.

- h. Remove nut (14) and piston (15). Discard nut (14).
- i. Remove and discard O-ring (16) from piston (15) bore.
- j. Remove tube (17).
- k. Slide gland (9) off rod (8).
- I. Remove O-rings (11 and 18) and backup ring (19) from gland (9). Discard O-rings (11 and 18).

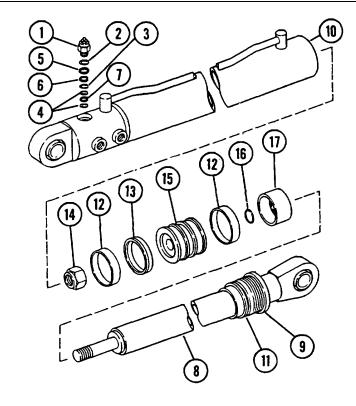
# **CAUTION**

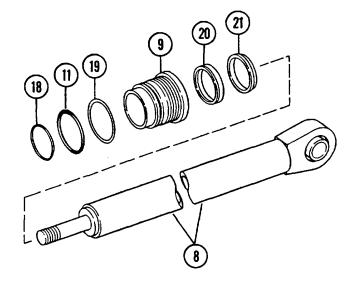
Do not nick or scratch seal groove during removal of seal (20) and rod wiper (21). Failure to follow this precaution will cause part damage.

### **NOTE**

Note direction that lip of seal (20) is facing before removal.

m. Remove seal (20) and rod wiper (21) from inside of gland (9).





# 16-18. BOOK HOIST CYLINDERS - REPAIR (Cont'd)

- n. Remove needle valve (22).
- o. Use snap ring pliers to remove one snap ring (23) from cylinder tube (10) and rod (8).
- p. Press out one bushing (24) from cylinder tube (10) and rod (8). Remove one snap ring (23) from each bushing (24).

#### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

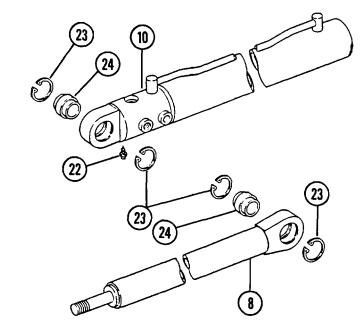
See Inspection Instructions, para. 2-11.

#### **ASSEMBLY**

### **NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. ASSEMBLE CYLINDER PARTS (1-24).
  - a. Install needle valve (22).
  - b. Press one bushing (24) in cylinder tube (10) and rod (8).
  - c. Install two snap rings (23) on each bushing (24).
  - d. Install seal (20) and rod wiper (21) inside gland (9). Ensure that seal (20) lip is positioned the same way as it was before disassembly.
  - Install backup ring (19) and new
     O-rings (11 and 18) on outside diameter of gland (9).



### 16-18. BOOM HOIST CYLINDERS - REPAIR (Cont'd)

- f. Slide gland (9) onto rod (8).
- g. Lubricate piston (15) inner diameter with clean hydraulic oil. Install new O-ring (16) inside bore of piston (15).
- h. Install tube (17).
- Use a cleaning solvent and lint free rag to clean threads on rod (8) and new nut (14).
- j. Slide piston (15) onto rod (8).
- k. Apply Loctite #271 on threads of rod (8) and nut (14). Install nut (14) on rod (8).
- Place rod (8) and piston (15) assembly on suitable supports to prevent damage during assembly.
- m. Install two wear rings (12) and one new seal (13) on piston (15).
   Position wear rings so that gaps are 180 degrees apart.

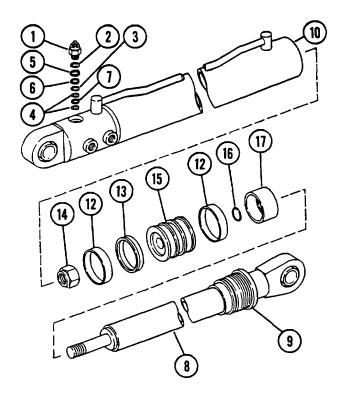
### **CAUTION**

Use care when installing rod (8) and piston (15) assembly. Keep rod (8) in line with cylinder tube (10) to prevent binding. Failure to follow this precaution will cause part damage.

- n. Lubricate cylinder tube (10) inner diameter, piston (15) outside diameter and gland (9) outside diameter with clean hydraulic oil.
- Position rod (8) and piston (15) assembly in cylinder tube (10).

### **NOTE**

Tighten gland (9) so that it is flush with end of cylinder tube (10). Do not overtighten gland (9).



- p. Tighten gland (9) onto cylinder tube (10)
- q. Install backup rings (2 and 3), Two backup rings (4) and three new O-rings (5, 6 and 7) on counterbalance valve (1).
- r. Install counterbalance valve (1).
- 2. INSTALL BOOM HOIST CYLINDER, TM10-3930-660-20.

### 16-18.1. HYDRAULIC JOYSTICK CONTROL VALVE - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

### **Initial Setup**

# **Tools**

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance, Common %2 Less Power

# **Equipment Condition**

Hydraulic joystick control valve removed, TM10-3930-660-20.

#### DISASSEMBLY

- 1. REMOVE BOOT (1) BY CAREFULLY PRYING IT FROM GROOVE IN SPECIAL NUT (2) AND OUT FROM UNDER BOOT CLAMP (3).
- 2. REMOVE SPECIAL NUT (2) AND PIVOT PLATE (4) FROM PIVOT BOLT (5).

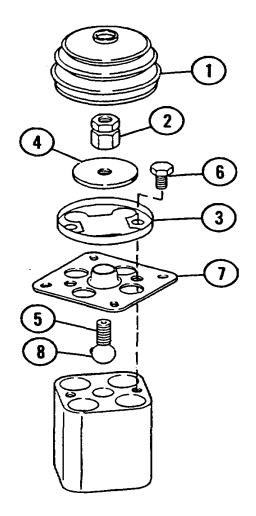
### NOTE

Plunger capsules are under spring compression. Hold mounting plate (7) down and remove capscrews (6) in even increments.

- 3. REMOVE TWO CAPSCREWS (6), BOOT CLAMP (3) AND MOUNTING PLATE (7).
- 4. PUSH PIVOT BOLT (5) DOWN OUT OF MOUNTING PLATE (7), USING CARE NOT TO LOSE BALL (8).

### Materials/Parts

Backup Ring (25)
Grease (App. B, Item 11)
Loctite 271 (App. B Item 43)
O-rings (11, 26 and 27)
Seal (12)
Transmission/Hydraulic Lubricating
Oil (App. B, Item 35)



# 16-18.1. HYDRAULIC JOYSTICK CONTROL VALVE - REPAIR (Cont'd)

### NOTE

There are four identical plunger capsule assemblies (9 - 19) and four identical metering capsule assemblies (20 - 27). STEPS 5 and 6 apply to all four.

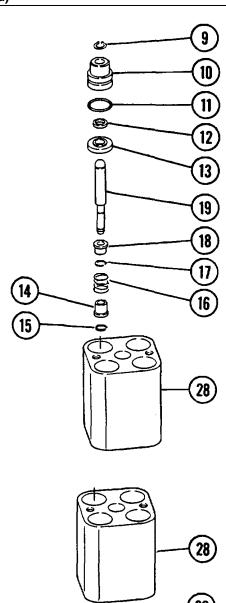
- 5. REMOVE PLUNGER CAPSULE PARTS (9-19)
  - a. Remove retaining ring (9) and cap (10).
  - b. Remove O-ring (11) and spool seal (12) from cap (10).
  - c. Remove retainer (13).
  - d. Push up on spring seat (14) and remove retaining ring (15).
  - e. Remove spring (16), retaining ring (17) and spring seat (18) from plunger (19).
- 6. REMOVE METERING CAPSULE PARTS (20-27).
  - Remove special plug (20) and withdraw items (20 - 27) from housing (28).
  - b. Remove pin (21), spring seat (22) and spring (23) from spool (24).
  - c. Remove backup ring (25) and O-rings (26 and 27) from special plug (20).
- 7. DISCARD O-RINGS (11, 26 AND 27), SEAL (12) AND BACKUP RING (25).

### **CLEANING**

SEE CLEANING INSTRUCTIONS, PARA. 2-10.

### **INSPECTION**

 INSPECT BOOT (1) FOR TEARS, STRETCHING OR SIGNS OF DETERIORATION.



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### 16-18.1. HYDRAULIC JOYSTICK CONTROL VALVE - REPAIR (Cont'd)

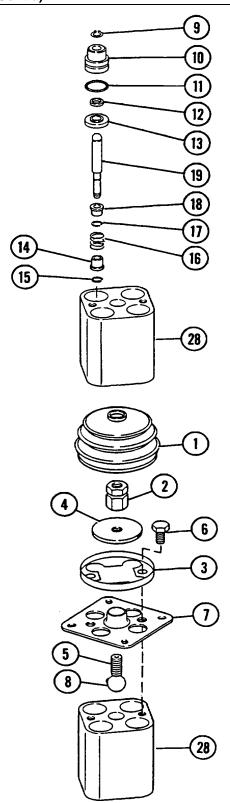
- 2. INSPECT SPRINGS (16 AND 23) FOR SIGNS OF STRETCHING OR DISTORTION.
- 3. INSPECT PLUNGERS (19) AND SPOOLS (24) FOR BURRS, NICKS OR SCORE MARKS.
- 4. INSPECT BORES IN CAPS (10) AND SPECIAL PLUGS (20) FOR BURRS, NICKS OR SCORE MARKS.
- 5. INSPECT SPECIAL NUT (2), PIVOT PLATE (4) AND PIVOT BOLT ASSEMBLY (5) THREADS FOR DAMAGE.

#### **ASSEMBLY**

- 1. APPLY A COAT OF TRANSMISSION/HYDRAULIC OIL, OE/HDO-10 TO ALL INTERNAL SLIDING SURFACES.
- 2. INSTALL METERING CAPSULE PARTS (20-27).
  - a. Assemble spool (24) to spring seat (22) using pin (21).
  - b. Install new O-rings (26 and 27) and backup ring (25) on special plug (20).
  - c. Place spring (23) on spool (24) and insert spool (24) in top of special spool (20).
  - Install special plug (20) and associated parts in bottom of housing (28). Tighten special plug to torque of 29 to 41 lb. ft.
  - e. Repeat STEPS a through d for other four sets of metering capsule parts.

### 16-18.1. HYDRAULIC JOYSTICK CONTROL VALVE - REPAIR (Cont'd)

- 3. INSTALL PLUNGER CAPSULE PARTS.
  - Install spring seat (18) and retaining ring (17) on plunger (19).
  - b. Install spring (16), spring seat (14) and retaining ring (15) on plunger (19).
  - c. Install retainer (13) and new seal (12) on plunger (19).
  - d. Install new O-ring (11) on cap (10) and install cap (10) on plunger (19). Secure with retaining ring (9).
  - e. Install assembled parts (9 19) in bore in housing (28).
  - Repeat STEPS a through e for three other plunger capsule assemblies.
- 4. APPLY GREASE TO CONTACT SURFACES OF PIVOT BOLT (5) AND MOUNTING PLATE (7).
- 5. INSTALL PIVOT BOLT (5) AND BALL (8)
  IN MOUNTING PLATE (7), FROM BOTTOM
  SIDE. USE CARE NOT TO DISLODGE BALL
  (8).
- 6. INSTALL BOOT CLAMP (3) ON MOUNTING PLATE (7). USE CARE NOT TO TEAR OR STRETCH IT.
- 7. APPLY LOCTITE #271 TO THREADS OF CAPSCREWS (6). INSTALL CAPSCREWS (6) AND TIGHTEN TO 15 LB. FT.
- 8. THREAD PIVOT PLATE (4) ONTO PIVOT BOLT (5) UNTIL BOTTOM OF PIVOT PLATE (4) JUST CONTACTS TOPS OF PLUNGERS (19). LOCK PIVOT PLATE (4) IN THAT POSITION WITH SPECIAL NUT (2). TIGHTEN SPECIAL NUT (2) TO TORQUE OF 29 TO 41 LB. FT.



### 16-19. MLRS ATTACHEENT CYLINDER - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Inspection
- d. Assembly

### Initial Setup

### Tools

Tool Kit, Automotive Mechanics

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

Wrench Set, Spanner, Consisting of the following:

Spanner Wrench, Frame Tilt Cylinder; Spanner Wrench, Carriage Tilt and

Attachment Hoist;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Gland;

Spanner Wrench, Fork Sideshift

Cylinder - Outer Piston;

Spanner Wrench, Boom Lift Cylinder

and Boom Extend Cylinder

### **Equipment Condition**

MLRS attachment cylinder removed, TM10-3930-660-20.

Materials/Parts

Container

Dry Cleaning Solvent P-D-680 (App. B,

Item 48)

Hydraulic Oil (App. B, Item 35) Lint-Free Rags (App. B, Item 38) Loctite #271 (App. B, Item 43)

Nut (14)

O-rings (5, 6, 7, 11, 17)

Seal (13)

# 16-19. MLRS ATTACHMENT CYLINDER - REPAIR (Cont'd)

### DISASSEMBLY

 USE A VISE WITH SOFT JAWS TO SECURE CYLINDER IN A HORIZONTAL POSITION FOR DISASSEMBLY.

#### **WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve (1) and allow pressure to escape before removing valve entirely.

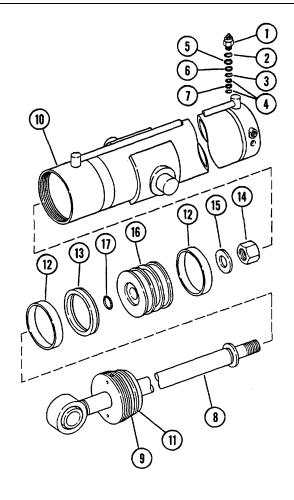
- RELIEVE PRESSURE IN CYLINDER BY SLOWLY REMOVING COUNTERBALANCE VALVE (1). DRAIN RESIDUAL OIL THROUGH VALVE HOLES INTO A SUITABLE CONTAINER.
- 3. REMOVE BACKUP RINGS (2 AND 3), TWO BACKUP RINGS (4), AND THREE O-RINGS (5, 6 AND 7) FROM EACH COUNTERBALANCE VALVE (1). DISCARD O-RINGS (5, 6 AND 7).
- 4. DISASSEMBLE CYLINDER PARTS (8-24).

# **CAUTION**

Do not scratch or damage the wear surface of rod (8), piston or gland (9). Follow this precaution to prevent failure of the cylinder.

t

- a. Pull rod (8) out approximately 5 inches for removal of gland (9).
- b. Place a container under gland (9) o catch oil contained in cylinder.



Use a spanner wrench to unscrew gland (9) from cylinder tube (10). Pull gland (9) out of cylinder far enough to unseat 0-ring (11). Allow oil to drain into container.

# **CAUTION**

Use care when removing rod (8) and piston assembly to prevent wear ring (12) damage. Keep rod (8) in line with cylinder tube to prevent binding.

- d. Remove rod (8) and piston assembly from cylinder tube (10).
- e. Place rod (8) and piston assembly on supports to prevent damage.
- f. Remove two wear rings (12).

### **CAUTION**

Do not nick or scratch seal groove during removal of seal (13). Failure to follow this precaution will cause part damage.

g. Cut seal (13) and discard.

### **NOTE**

The nut (14) may need to be heated with a torch for removal.

- h. Remove nut (14), washer (15) and piston (16). Discard nut (14).
- i. Remove and discard O-ring (17) from piston (16) bore.

# 16-19. MLRS ATTACENT CYLINDER - REPAIR (Cont'd)

- j. Remove washer (18) and gland (9) off rod (8).
- k. Remove O-ring (11) and backup ring (19) from gland (9). Discard O-ring (11).
- I. Remove lock pellet (20) if necessary.

### **CAUTION**

Do not nick or scratch seal groove during removal of seal (21) and rod wiper (22). Failure to follow this precaution will cause part damage.

### **NOTE**

Note direction that lip of seal (21) is facing before removal.

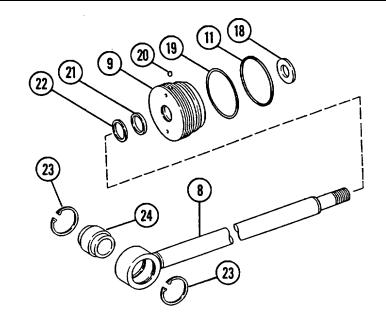
- m. Remove seal (21) and rod wiper (22) from inside of gland (9).
- Use snap ring pliers to remove one snap ring (23) from bushing (24).
- o. Press out bushing (24) from rod (8). Remove other snap ring (23) from bushing (24).

### **CLEANING**

See Cleaning Instructions, para. 2-10.

### **INSPECTION**

See Inspection Instructions, para. 2-11.



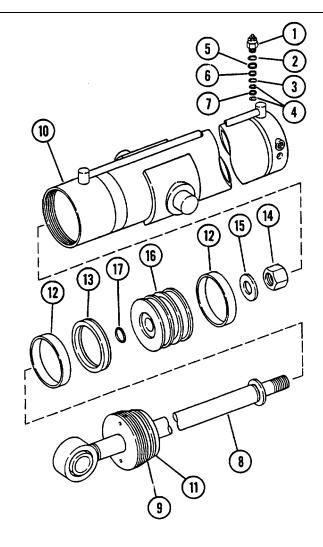
# 16-19. MLRS ATTACHMENT CYLINDER - REPAIR (Cont'd)

### **ASSEMBLY**

#### NOTE

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- 1. ASSEMBLE CYLINDER PARTS (1-24).
  - a. Press bushing (24) in rod (8).
  - b. Install two snap rings (23) on bushing (24).
  - c. Install seal (21) and rod wiper (22) inside gland (9).
  - d. If removal was necessary, install lock pellet (20).
  - e. Install backup ring (19) and new O-ring (11) on outside diameter of gland (9).
  - f. Slide gland (9) and washer (18) onto rod (8).
  - g. Lubricate piston (16) inner diameter with clean hydraulic oil. Install new O-ring (17) inside bore of piston (16).
  - h. Use a cleaning solvent and lint free rag to clean threads on rod (8) and nut (14).
  - i. Slide piston (16) and washer (15) onto rod (8).
  - j. Apply Loctite #271 on threads of rod (8) and nut (14). Install nut (14) on rod (8).



## 16-19. MLRS ATTACBEIENT CYLINDER - REPAIR (Cont'd)

- Place rod (8) and piston (16) assembly on supports to prevent damage during assembly.
- Install two wear rings (12) and one new seal (13) on piston (16).
   Position wear rings so that gaps are 180 degrees apart.

## **CAUTION**

Use care when installing rod (8) and piston (16) assembly. Keep rod (8) in line with cylinder tube (10) to prevent binding.

- m. Lubricate cylinder tube (10) inner diameter, piston (16) outside diameter and gland (9) outside diameter with clean hydraulic oil.
- n. Position rod (8) and piston (16) assembly in cylinder tube (10).

### NOTE

Tighten gland (9) so that it is flush with end of cylinder tube (10). Do not overtighten gland (9).

- o. Tighten gland (9) onto cylinder tube (10).
- p. Install backup rings (2 and 3), two backup rings (4) and three new O-rings (5, 6 and 7) on counterbalance valve (1).
- q. Install counterbalance valve (1).
- 2. INSTALL MLRS ATTACHMENT CYLINDER, TM10-3930-660-20.

# 16-20. HYDRAULIC HOSES - REPAIR

This task covers:

Repair

# Initial Setup

**Tools** 

Tool Outfit, Hydraulic System Test and Repair (HSTRU)

# **Equipment Condition**

Hydraulic hose(s) removed from vehicle.

# **REPAIR**

FOR HYDRAULIC HOSE REPAIR/MANUFACTURE REFER TO TM9-4940-468-14.

### 16-21. PISTON PUMP - REPAIR

### This task covers:

- a. Disassembly
- b. Cleaning
- c. Assembly

### **Initial Setup**

### **Tools**

Shop Equipment, Automotive Maintenance and Repair, Common #1 Less Power

### Fabricated Tools:

Bearing Removal Tool (App. C, Fig. C-8)
Bearing Race Removal Tool (App. C, Fig. C-9)
Shaft Seal Driver (App. C, Fig. C-10)
Bearing Race Removal Tool (App. C, Fig. C-II)
Bearing Installation Tool (App. C, Fig. C-12)
Bearing Race Installation
Tool (App. C, Fig. C-13)
Bearing Race Installation

# Materials/Parts

Capscrew,  $\frac{1}{2}$  - 13 x 3-3/4 in. Lg. (B) (Qty. 1) Flat Washer , 1/16 x 1.575 in O. D. (A) (As req'd) Gaskets (4, 10) Nut,  $\frac{1}{2}$  - 13 (C) (Qty. 1) O-rings (5, 32, 46)

## **Equipment Condition**

Piston pump removed, TM10-3930-660-20.

Tool (App. C, Fig. C-14)

#### **DISASSEMBLY**

### NOTE

Clean outside surfaces of the valve block and compensator before disassembly.

- 1. REMOVE COMPENSATOR (1).
  - a. Remove four screws (2) and pull compensator (1) from valve block (3).
  - b. Remove gasket (4) and O-ring (5) from compensator (1). Discard gasket and O-ring.
- 2. REMOVE ROTATING GROUP PARTS FROM HOUSING (6) AND VALVE BLOCK (3).

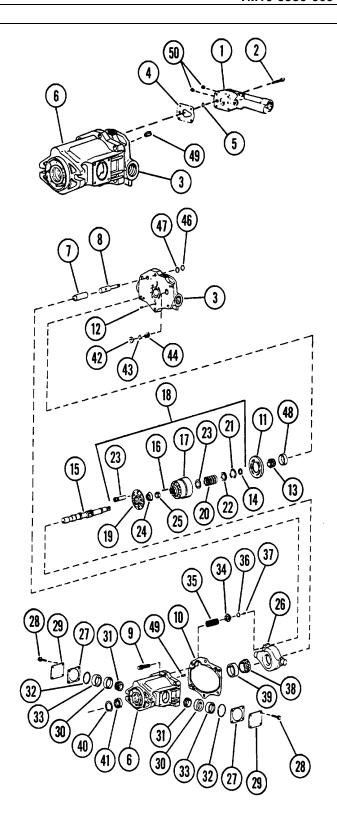
#### **NOTE**

Piston (7) will slide from rod piston (8) and drop into the pump housing (6) when valve block (3) is removed from the pump housing (6).

- a. Remove six screws (9) and remove valve block (3) from housing (6).
- b. Remove and discard gasket (10).
- c. Remove wafer plate (11) from valve block (3).
- d. If necessary, remove pin (12) from valve block (3).
- e. Remove bearing (13) and spacer (14) from drive shaft (15).

# **NOTE**

Three pins (16) will drop from the cylinder block (17) when rotating group parts (18) are removed from shaft (15).



#### NOTE

The rotating group (18) consists of components (11, 14, 16, 17, 19-25).

- f. Hold shoe plate (19) with both hands to prevent rotating group parts from separating during removal, then remove rotating group parts (18) from pump housing (6).
- g. Remove pin retainer (24) from cylinder block (17).
- h. Remove piston (7) from housing (6).
- 3. DISASSEMBLE CYLINDER BLOCK ASSEMBLY.

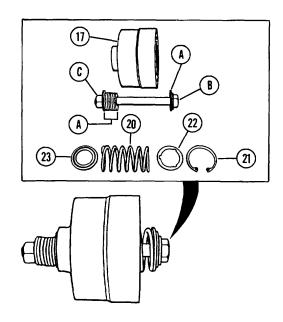
## **WARNING**

Spring (20) located in the cylinder block (17) is under high tension and can cause severe personal injury if retaining ring (21) is not removed correctly.

- a. Place flat washers (A), as required, under head of capscrew (B). Slide capscrew (B) through retaining ring (21) and spring (20) until threaded end of capscrew is visible through hole on other side of cylinder block (17).
- b. Place additional flat washers (A), as required, and nut (C) on threaded end of capscrew (B).
- Carefully tighten nut (C) and capscrew (B) until spring tension is removed from retaining ring (21).

### **NOTE**

Use care when handling close tolerance parts that are removed in steps d and e, to prevent burrs from forming.

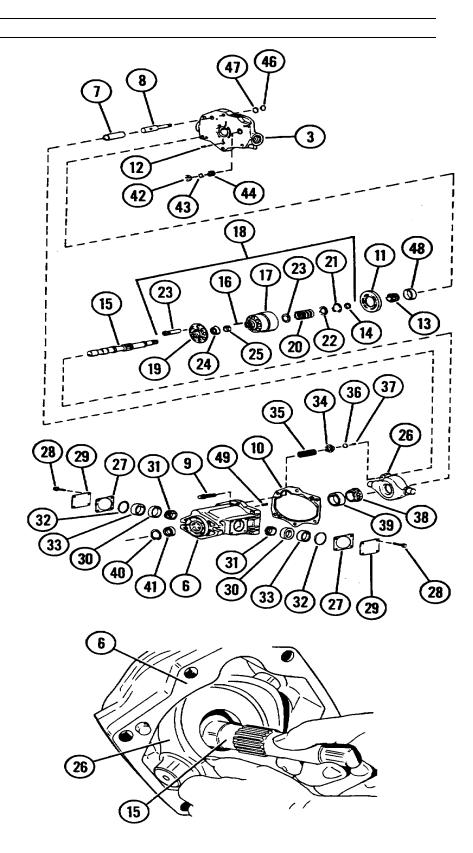


- d. Remove retaining ring (21). Carefully loosen nut (C) and capscrew (B) until spring (21) is fully extended. Separate spring washer (22), spring (21), and spring washer (23) from cylinder block (17).
- 4. REMOVE YOKE (26) AND SHAFT (15).

#### **NOTE**

Be careful not to damage shims (27) when removing pintle covers (28).

- a. Remove eight screws (28), then remove pintle covers (29) from each side of housing (6).
- b. Retain shims (27), if possible, and use a micrometer to measure total shim thickness. If bearing subassemblies (30, 31) are not defective, the same shims (27), or a new shim with the same thickness, will be needed to preload bearing subassemblies (30, 31) at installation.
- c. Remove O-rings (32) and bearing spacer (33) from each pintle.
- d. Slide yoke (26) from side to side to loosen yoke bearing races (30) within housing (6). Use an open end wrench between yoke (26) and pintle bearing (31) to help remove races (30). Apply pressure at the approximate center of bearing (31) and allow bearing rollers to gently press race (30) out of housing (6).
- e. Remove yoke (26) and drive shaft (15) from housing (6) as an assembly. Turn yoke (26) at an angle and slide the two parts out of housing (6).
- f. Remove seat (34) and yoke spring (35). Seat (36) and roll pin (37) will be attached to yoke (26).



5. REMOVE BEARING (38) FROM SHAFT (15) IF NECESSARY.

Use fabricated tool (App. C, Fig.C-8) and an arbor press to remove bearing (38) from shaft (15).

6. REMOVE BEARING RACE (39) FROM HOUSING (6), IF NECESSARY.

Use fabricated tool (App. C, Fig.C-9) and an arbor press to remove bearing race (39) from housing (6). Discard bearing race (39).

- 7. REMOVE RETAINING RING (40) AND SHAFT SEAL (41).
  - a. Remove retaining ring (40).
  - b. Use fabricated tool (App. C, Fig. C-10) and arbor press to remove shaft seal (41) from housing (6).
- 8. DISASSEMBLE VALVE BLOCK (3) IF NECESSARY.

### **NOTE**

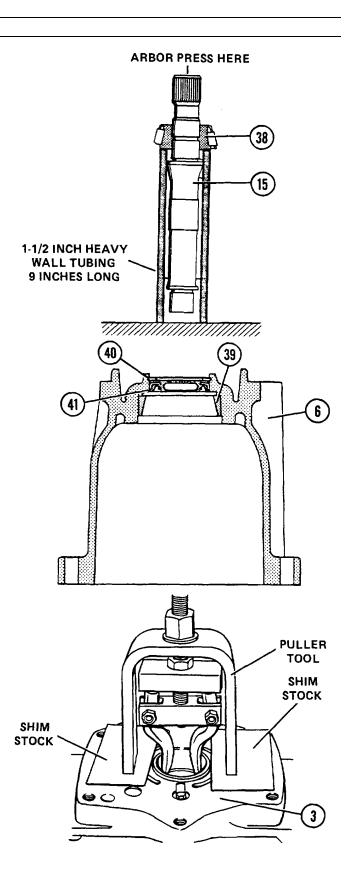
Do not disassemble check valve parts (42) through (44) unless there is a problem with valve operation. See INSPECTION, steps 3 and 8.

- a. If necessary, remove seat (42), valve (43), and spring (44) from valve block (3).
- b. Remove plug (45), O-ring (46), retaining ring (47), and piston rod (8) from valve block (3).

### **CAUTION**

Be careful not to scratch the face of the valve block during bearing race (48) removal.

c. Use fabricated tool (App. C, Fig. C-II) and shim stock to remove bearing race (48) from valve block (3).



- IF NECESSARY, REMOVE TWO ALIGNMENT PINS (49) FROM HOUSING (6).
- 10.IF NECESSARY, REMOVE TWO PLUGS (50) FROM COMPENSATOR (1).

#### **CLEANING**

THOROUGHLY CLEAN AND DRY ALL PARTS IN ACCORDANCE WITH REQUIREMENTS IN PARAGRAPH 2-10.

#### **INSPECTION**

- 1. INSPECT ALL PARTS IN ACCORDANCE WITH REQUIREMENTS IN PARAGRAPH 2-11.
- 2. CHECK PISTON (7) MOVEMENT.

Turn piston (7) on rod (8) 360 degrees. If binding occurs, replace piston and rod.

- 3. CHECK THAT CHECK VALVE SEAT (42) IS TIGHT WITHIN VALVE BLOCK (3) AND THAT IT DOES NOT PROTRUDE ABOVE THE VALVE BLOCK FACE.
- 4. INSPECT PINS (16) FOR EQUAL LENGTH, EXCESSIVE WEAR, AND BENDS.

Replace all pins (16) if one is defective.

5. INSPECT SHOE PLATE (19) FOR EXCESSIVE WEAR AND CRACKING IN THE AREA OF SPHERICAL WASHER (24).

If heavy wear or cracks are found, replace the shoe plate (19) and spherical washer (24) at the same time.

- 6. INSPECT PISTON SHOE (23).
  - a. Measure end play between piston and shoe. End play must not exceed 0.005 inches between piston and shoe.

 Measure face thickness of each shoe. The face thickness of all shoes must be within 0.001 inches of each other.

## 7. INSPECT CYLINDER BLOCK (17).

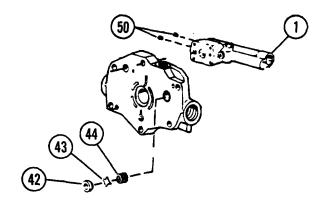
- a. Inspect cylinder block bore for wear, scratches, and/or erosion between cylinders. Check the spring, washers, and retaining ring located within the cylinder block for wear.
- b. Check each cylinder block bore for excessive wear by sliding the piston and shoe subassemblies through the bores. If binding is evident, clean cylinder block and piston, lubricate parts with clean hydraulic fluid and again check for binding.

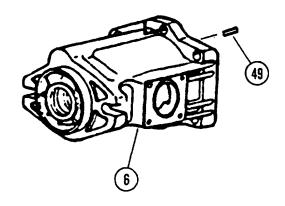
## 8. INSPECT CHECK VALVE (43).

- a. Press check valve (43) against spring (44). Valve (43) should return and hold firm against seat (42).
- b. If replacement is necessary, spring (44), valve (43), and seat (42) must be replaced as a set.

### **ASSEMBLY**

- 1. IF REMOVED, INSTALL TWO PLUGS (50) TO COMPENSATOR (1).
- 2. IF REMOVED, INSTALL ALIGNMENT PINS (49) INTO HOUSING (6).
- 3. INSTALL NEW DRIVE SHAFT BEARING (38) AND SEAL (41).
  - a. Use fabricated tool (App. C, Fig. C-12) and an arbor press to press shaft (15) through bearing (38).
     Press shaft until bearing (38) bottoms against drive shaft (15) shoulder.



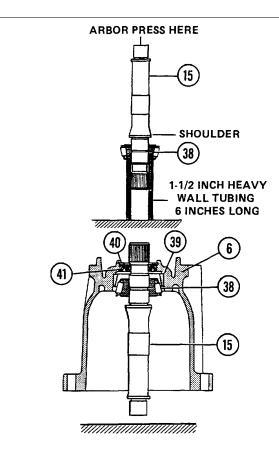


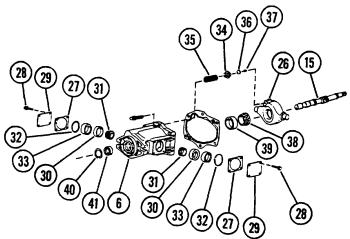
- b. Use fabricated tool (App. C, Fig. C-13) and an arbor press to install new bearing race (39) into housing (6). Press race until it bottoms against housing shoulder.
- c. Install shaft (15) into housing

   (6) and check that bearing
   rollers (38) move freely in
   bearing race (39) as shaft is
   turned. Remove shaft (15) from housing.
- d. Use fabricated tool (App.C, Fig. C-10) and an arbor press to install new shaft seal (41) into housing (6). End of seal (41) must be positioned 0.25 inches from edge of housing (6) (just below retaining ring (40) groove).
- e. Install retaining ring (40).
- f. Wrap plastic tape around spline end of drive shaft (15) to prevent damage to shaft seal (41).

#### 4. ASSEMBLE PUMP HOUSING COMPONENTS.

- a. Place housing (6) on a clean, flat surface with shaft seal (41) end down.
  - b. Insert spline end of drive shaft (15) into housing (6).Position drive shaft so that front shaft bearing (38) is inside bearing race (39).
- c. Install yoke spring (35) and seat (34) into housing (6).
- d. Install yoke (26) into housing (6).
- e. Install pintle bearings (31) on each end of yoke (26), and install bearing races (30).





- f. Install bearing spacer (33) at one pintle end.
- g. Install new O-ring (32) against spacer and into groove at one pintle end.
- h. Install a 0.010 inch shim under pintle cover (29) at one pintle end.
- Install four pintle cover screws (28) into pintle cover installed in step h above, and tighten screws to 175-185 lb. in.
- j. Place housing (6) on its side so other end of pintle is facing up. Install bearing spacer (33).
- k. Turn yoke (26) back and forth to seat bearings (31) in bearing races (30).

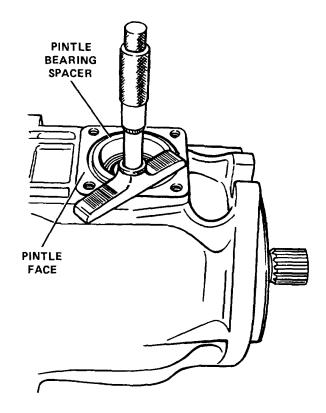
## 5. INSTALL CORRECT PINTLE SHIMS (27).

- a. With spacer (33) fully installed against bearing race (30), measure height of spacer with respect to the housing pintle face using a micrometer. Take measurements in two places, 180 degrees apart.
- Average the two readings taken in step a above to obtain a nominal value.

### **NOTE**

A 0.007 - 0.009 inch preload is required on the pintle bearings.

c. Determine the number of shims required to obtain a preload between 0.007 and 0.009 inches by subtracting the nominal preload (0.008) from the calculated nominal valve (step b).



Example: Let's assume the depth readings were 0.029 and 0.027 inches. Add these two figures together and divide by two to obtain the average (nominal value):

0.029 + 0.027 = 0.0560.056/2 = 0.028 (nominal calculated value)

Nominal Calculated Value -Nominal Preload Value = Required Shim Thickness

0.028 - 0.008 = 0.020 inches of shim thickness

#### **NOTE**

If calculated shim thickness is greater than 0.020 inches, another shim must be added to the opposite side of the yoke to reduce total shim thickness to less than 0.020. Shim thickness at either pintle must not exceed 0.020 inches. This is necessary to provide proper O-ring compression and prevent pintle seal leakage.

- d. Install correct shims (27).
- e. Install pintle cover (29) and cross tighten cover screws (28) to 175-185 lb. in.

#### **NOTE**

Yoke (26) rotation will be stiff, but should be loose enough to be moved by hand (approximately 20 lb. in. torque). This tightness/drag indicates that bearings (31) are preloaded. If yoke (26) cannot be moved by hand, preload is too great and the preload adjustment must be repeated until correct.

#### 6. ASSEMBLE VALVE BLOCK.

a. Use fabricated tool (App. C, Fig. C-14) and an arbor press to install new bearing race (48).
 Press race (48) until it bottoms against shoulder in valve block (3).

#### **NOTE**

Check flatness of valve block face in area around locating pin holes (B) and at mounting screw (A) holes. If necessary, use an India stone to remove burrs or raised metal in these areas.

b. Install pipe plug (45) into valve block.

#### 7. ADJUST SHAFT BEARING PRELOAD.

#### **NOTE**

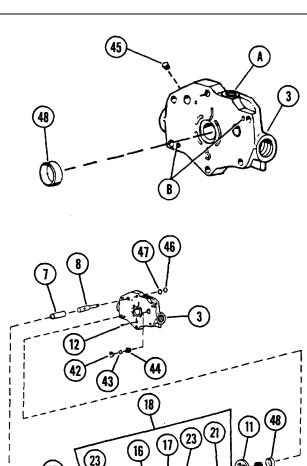
If the shaft bearings, shaft, valve block or housing were not replaced, use the bearing spacer removed during disassembly to preload the shaft and perform step g. If any of these items were replaced, preload adjustment is required.

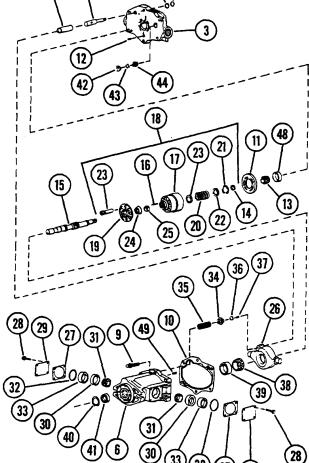
#### **NOTE**

The bearing spacer kit contains several different sizes of bearing spacers (14).

- a. Install thickest bearing spacer
   (14) over shaft (15), with chamfer facing into housing (6).
- Slide bearing (13) onto shaft (15).Small diameter of bearing must face out of housing.
- c. Temporarily install housing (6) on valve block (3).Do not install gasket (10) or rotating group parts (18) at this time.

  Turn shaft (15) to seat bearings, then tighten six screws (9) to 5 lb. in.





- d. Use tapered feeler gauge to measure opening between valve block (3) and housing (6).Four measurements should be obtained equidistant around unit. Average four readings by adding them together and dividing by 4. Calculate thickness of shaft bearing spacer as shown in the following example:
  - + 0.150 in. = Measured thickness of bearing spacer
  - 0.027 in. = Average gap (estimated)
  - + 0.003 <u>+</u>
    - 0.001 in. = Preload setting
  - + 0.020 in. = Compressed

thickness of gasket

0.146 + 0.001 in. = Required bearing spacer thickness to provide a 0.003 + 0.001 in. bearing preload

- e. Remove the six mounting screws (8), then remove housing (6) from valve block (3).
- f. Remove bearing (13) and thickest bearing spacer (14) from shaft (15).
- g. Locate bearing spacer (14) in kit with dimensions calculated in step d above. Place spacer (14) next to the new bearing (13) on shaft (15), with chamfer of spacer facing the shaft shoulder. Use the original spacer (14) and bearing (13) if preload is not required. Set aside until final assembly is performed.

#### 8. ASSEMBLE ROTATING GROUP PARTS.

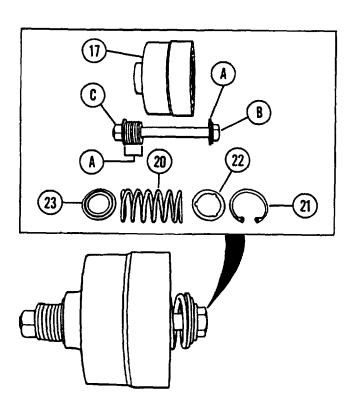
### WARNING

Spring (20) can cause severe personal injury if retaining ring (21) is not properly installed. Use capscrew (A), flat washers (B), as required, and nut (C) to temporarily relieve pressure of spring (20) when installing retaining ring (21).

#### NOTE

Use care when assembling parts in cylinder block to prevent burrs from forming.

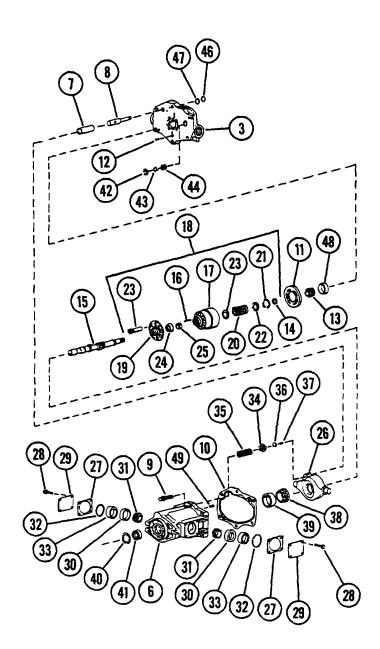
- a. Install spring (20), spring washer (23), and spring washer (22) in cylinder block (17).
- b. Place flat washers (A), as required, on hex end of capscrew (B). Insert capscrew (B) through spring (20) until threaded end of capscrew is visible through hole on other side of cylinder block (17).
- c. Place additional flat washers
  (A), as required, and nut (C) on threaded end of capscrew (B).
- d. Carefully tighten nut (C) and capscrew (B), and install retaining ring (21).
- e. Slowly and carefully loosen nut (C) and capscrew (B) until pressure of spring (20) is on retaining ring (21).Remove capscrew (B), flat washers (A), and nut (C) from cylinder block (17).



- f. Install pin retainer (24) into cylinder block (17) with the open end of retainer facing away from the large spline openings. Position pin retainer (24) so that it is approximately 1/4 inch below the surface of the cylinder block.
- g. Install three pins (16) into cylinder block (17) until they bottom against spring washer (23) already installed in cylinder block.
- h. Place spherical washer (24) on top of the three pins (16). Install shoe plate (19) and nine piston and shoe assemblies (23) over spherical washer (24) and into cylinder block (17). Move shoe plate (19) in a side to side and up and down motion to make sure each piston moves freely in its bore.
- Place housing (6) on its side and hold shaft (15) horizontal. Install rotating group parts (18) into housing (6). Turn shaft (15) to match splines in cylinder block (17) and spherical washer (24).
- j. Place new gasket (10) over pins (49) and put housing (6) aside for final assembly.
- 9. ASSEMBLE AND INSTALL VALVE BLOCK (3).

#### NOTE

Lubricate all moving parts of piston pump with hydraulic oil to facilitate assembly and provide initial lubrication. Pour hydraulic oil liberally over rotating group parts and wafer plate as these components are without lubrication until the pump primes.



a. If removed, install locating pin (12) in valve block (3).

### **NOTE**

The side of the wafer plate with the locating pin groove must face the valve block.

b. Assemble wafer plate (11) over bearing race (48) and plate groove over locating pin (12).

### **CAUTION**

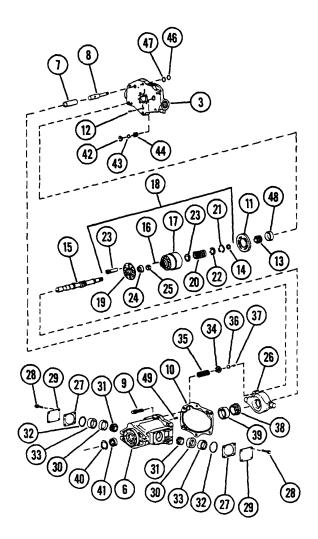
Wafer plate (11) must be flat against valve block face. Check to make sure it does not rock back and forth. If rocking motion occurs, make sure locating pin (12) is bottomed out in the valve block (3). Wafer plate rocking will induce high stress conditions and cause fractures in the wafer plate.

- c. Place valve block (3) on its side. Install piston rod (8) into valve block (3) and attach retaining ring (47).
- d. Install new O-ring (46) in the piston rod (8) O-ring groove.

#### **CAUTION**

Be careful not to allow the piston to drop from piston rod as this could damage the piston.

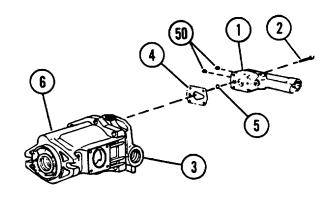
- e. Install piston (7) over piston rod (8).
- f. Assemble valve block (3) to housing (6) with six screws (9).
- g. Cross tighten screws (9) to bring valve block and housing evenly together against gasket (10). Torque screws (9) to 60-70 lb. ft.



h. Check shaft torque to verify correct bearing preload. If shaft torque is greater than 6 lb. ft., adjust shaft bearing preload (see step 5 above).

# 10.INSTALL COMPENSATOR (1).

- a. Install new O-ring (5) in compensator, and new gasket (4) on compensator face surface.
- b. Install compensator (1) on valve block (3) and install four screws (2).
- c. Cross tighten screws to 60-70 lb. in. torque.



16-143/(16-144Blank)

## **APPENDIX A**

## **REFERENCES**

# A-1. Scope.

This appendix lists forms, field manuals, technical manuals, and other publications referenced in this manual and which apply to intermediate direct support and general support maintenance of the 6KVRRTFL.

A-2. Department of the Army Pamphlets.					
Consolidated Index of Army Publications and Blank Forms					
The Army Maintenance Management System (TAMMS) DA Pam 738-750					
A-3.Forms.					
Recommended Changes to Equipment Technical PublicationsDA Form 2028-2					
Organizational Control Record for Equipment					
Equipment Inspection and Maintenance Worksheet					
Maintenance Request DA Form 2407					
Preventive Maintenance Schedule and Record DA Form 314					
Processing and Deprocessing Record for Shipment, Storage, and Issue of Vehicles and Spare Engines					
Product Quality Deficiency Report (NSN 7540-00-105-0078)					
A-4.Field Manuals.					
Camouflage FM 5-20					
First Aid for Soldiers FM 21-11					
Basic Cold Weather Manual FM 31-70					
Northern Operations FM 31-71					
Mountain Operations (How To Fight)					
A-5.Lubrication Order.					
Truck, Forklift, 6, 000 lbs., Variable Reach, Rough TerrainL010-3930-660-12					

# A-6.Technical Bulletins.

Warranty Program for Truck, Forklift, 6, 000 lbs., Variable Reach, Rough Terrain
Occupational and Environmental Health: Hearing ConservationTB MED 501
Equipment Improvement Report and Maintenance Digest (US Army Tank-Automotive Command) Tank-Automotive Equipment
Non aeronautical Equipment Army Oil Analysis Program (AOAP)TB 43-0210
A-7.Technical Manuals.
Operator's Manual for Truck, Forklift, 6, 000 lbs., Variable Reach, Rough TerrainTM10-3930-660-10
Hand Receipt for Components of End Item (COEI), Basic Issue Items (BII), and Additional Authorized List (AAL) for Operator's Manual for Truck, Forklift, 6, 000 lbs., Variable Reach, Rough Terrain TM10-3930-660-IOHR
Unit Maintenance Manual for Truck, Forklift, 6, 000 lbs., Variable Reach, Rough TerrainTM10-3930-660-20
Unit Maintenance, Intermediate Direct Support, and Intermediate General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools List) for Truck, Forklift, 6, 000 lbs., Variable Reach, Rough Terrain TM10-3930-660-24P
Inspection, Care, and Maintenance of Antifriction BearingsTM9-214
Operator's Manual for Welding Theory and ApplicationTM9-237
Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance Materiel and Related Materiels Including Chemicals
Operator and Organizational Maintenance Manual Including Repair Parts and Special Tools List Simplified Test Equipment for Internal Combustion Engines (STE-ICE) (4910-00-124-2554)TM9-4910-571-12&P
Operator's, Organizational, Direct Support, and General support Maintenance Manual for Lead-Acid Storage Batteries; 4HN, 24V, (NSN 6140-00-069-3528) MS75047-1; 2HN, 12 V (6140-00-057-2553) MS 35000-1; 6TN, 12V (6140-00-057-2554) MS35000-3
Painting Instructions for Field UseTM43-0139
-

Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)TM 750-244-3
Tool Outfit, Hydraulic Systems Test and Repair (HSTRU) (4940-01-036-5784)TM9-4940-468-14
A-8.Specifications and Standards.
Dry Cleaning Solvent Fed Spec P-D-680
Methyl Ethyl Ketone, TechnicalTT-M-261
Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
A-9.Other Publications.
Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items)
Army Medical Department Expendable/Durable Items

A-3/(A-4 Blank)

#### **APPENDIX B**

#### EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

#### Section I. INTRODUCTION

- **B-1. General.**This appendix lists expendable supplies and materials you will need to operate and maintain the 6KVRRTFL. This listing is for informational purposes only and is not authorized to requisition the needed items. These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items) or CTA 8-100, Army Medical Department Expendable/Durable items.
- **B-2. Explanation Of Columns**. The following provides an explanation of the columns found in the tabular listing:
- a. <u>Item Number</u>, <u>Column 1.</u>This column indicates the number assigned to the entry in the listing.
- b. <u>Level, Column 2.</u> This column identifies the lowest level of maintenance that requires the listed item. The symbol designations for the various maintenance categories are as follows:

SYMBOL	MAINTENANCE CATEGORY
С	Operator or Crew
0	Organizational Maintenance
F	Direct Support Maintenance
н	General Support Maintenance
D	Depot Maintenance

- c. <u>National Stock Number (NSN)</u>, <u>Column 3</u>. This column indicates the NSN assigned to the item, and will be used for requisitioning purposes.
- d. <u>Description, Column 4.</u> This column indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturers (FSCM) in parenthesis followed by the part number.
- e. <u>Unit of Measure (U/M), Column 5.</u>This column indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., EA, IN, PR). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

**Table B-1.Expendable Supplies and Materials List** 

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
			Adhesive 3-M No.80 (04963)	
			(TRAK 8526038)	
1	F	8010-01-260-59151		Canoz.
			Alumilastic	
2	F			OZ.
			Compound, Anti-seize, MIL-T-83483 (81349)	
3	F	8030-00-293-32851		oz.
			Crocus, Cloth	
4	F	5330-01-221-0872		
			Cloth, Medium Grit, Emery	
5	F	5350-00-584-4654		
			Compound, Prussian Blue Marking	
6	F	8010-00-652-362		oz.
			Compound, Sealing RTV-732 Black (71794)	
7	F	8040-00-851-02111	1 Tube	tu.
			Compound, Valve Lapping 34B (77247)	
8	F	5350-01-010-70071	1Can	oz.
			Detergent, Laundry	
9	F			
			Gloves, Insulated	
10	F		1 Pair	pr.
			B-2	

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
			Grease, Automotive and Artillery, GAA, MIL-G-10924 (81349) (SAE-J-310)	
11	F	9150-00-935-1017	14 oz. Cartridge	OZ.
12	F	9150-00-190-0905	6-1/2 Pound Can	lb.
13	F	9150-00-190-0907	35 Pound Can	lb.
			K & W Copper Coat 1504	
14	F	8040-00-264-3860		OZ.
			Lubricant, Delco-Remy 1948791, AMOCO 1272	
15	F			oz
			Lubriplate No.105 ST40334 (90536)	
16	F	7050-00-961-76631	1Can	cn.
			Oil, Fuel, Diesel, DF-2 Regular VVF800 (81349)	
17	F	9140-00-286-5295	5 Gallon Can	gal.
18	F	9140-00-286-5296	55 Gallon Drum	gal.
19	F	9140-00-286-5294	Bulk	gal.
			Oil, Fuel, Diesel, DF-1 Winter VVF800 (81349)	
20	F	9140-00-286-5287	5 Gallon Can	gal.
21	F	9140-00-286-5288	55 Gallon Drum	gal.
22	F	9140-00-286-5286	Bulk	gal.
			Oil, Fuel, Diesel, DF-A Arctic WF800 (81349)	
23	F	9140-00-286-5282	5 Gallon Can	gal.
24	F	9140-00-286-5284	55 Gallon Drum	gal.
25	F	9140-00-286-5283	Bulk	gal.
			B-3	

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
			Oil, Lubricating, Engine OE/HDO-15/40, MIL-L-2104D (81349)	
26	F	9150-01-152-4117	1 Quart Can	qt.
27	F	9150-01-152-4118	5 Gallon Can	gal.
28	F	9150-01-152-4119	55 Gallon Drum	gal.
			Oil, Lubricating, Engine Arctic OEA, MIL-L-46167 (81349)	
29	F	9150-00-402-4478	1 Quart Can	qt.
30	F	9150-00-402-2372	5 Gallon Can	gal.
31	F	9150-00-491-7197	55 Gallon Drum	gal.
			Oil, Lubricating, Gear Multipurpose GO 80/90 MIL-L-2105D (81349)	
32	F	9150-01-035-5392	1 Quart Can	qt.
33	F	9150-01-035-5393	5 Gallon Can	gal.
34	F	9150-01-035-5394	55 Gallon Drum	gal.
			Oil, Lubricating, Transmission/ Hydraulic OE/HDO-10 MIL-L-2140D (81349)	
35	F	9150-00-189-6727	1 Quart Can	qt.
36	F	9150-00-191-2772	55 Gallon Drum	gal.
			Pads, Scotch Briter	
37	F			
			Rags, Lint Free A-A-531 (58536)	
38	F	7920-00-205-35701	Balebe.	
			Sandpaper No.100	
39	F	5350-00-619-9166		
			B-4	

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
			Sealant, Loctite 222	
40	F		1 bt.	oz.
			Sealant, Loctite 242 MIL-S-46163 Type II Grade N (80244)	OZ.
41	F	8030-01-014-5869		oz.
			Sealant, Loctite 262	
42	F			oz.
			Sealant, Loctite 271 MIL-S-46163 Type I Grade L (80244)	oz.
43	F	8030-01-158-6070		OZ.
			Sealant, Loctite 277 MIL-S-46163 Type I Grade L (80244)	OZ.
44	F	8030-01-063-7510		OZ.
			Sealant, Loctite 59241	
45	F	8030-00-204-9149		
			Sealant, Loctite 767-64	
46	F	8030-00-251-3980		OZ.
			Sealant, Permatex, Aviation Form A Gasket No.3 MIL-S-45180C (77247)	
47	F	8030-00-656-1426	1 Tube	tu.
			Solvent, Dry Cleaning P-D-680 (81348)	
48	F	6850-00-664-5685	1 Quart Container	qt.
49	F	6850-00-281-1985	1 Gallon Container	gal.
50	F	6850-00-285-8011	1 Drum	dr.
			B-5	

(1)	(2)	(3)	(4)	TM10-
ITEM NUMBER	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
			Solvent, Rust Penetrating	
51	F			
			Tags	
52	F		1 Carton	ctn.
			Tape Electrical	
53	F		1 Dispensers.	dis.
			Tie Wraps	
54	F		1 Carton	ctn.
*National Sto	ck Numbers prior to FDEF	and sizes/quantitie	s to be provided (where not specified) by	
	1			

#### **APPENDIX C**

### **ILLUSTRATED LIST OF MANUFACTLURED ITEMS**

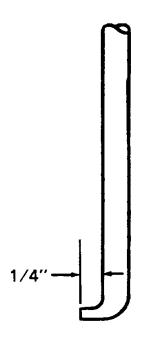
#### **Section I.INTRODUCTION**

C-1. **General.** This appendix includes complete instructions for making items authorized to be manufactured or fabricated at the Direct Support and General Support maintenance levels.

## Section II.MIFACTURIED ITES ILLUSTRATIONS

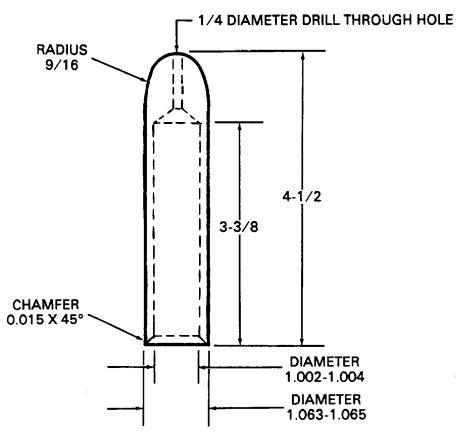
C-2. **Manufactured Items**. All bulk materials needed for manufacture of an item are shown on the illustration.

Figure C-1
Tandem Gear Pump Seal Removal Tool



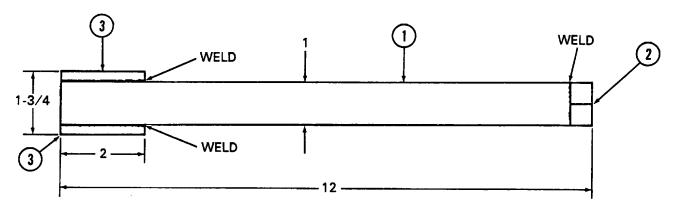
- 1.Fabricate from a screwdriver.
- 2.Heat screwdriver tip and bend as shown.
- 3. Grind tip to fit notch behind shaft seal.

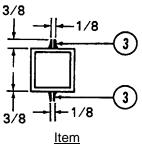
Figure C-2
Tandem Gear Pump Drive Gear Installation Tool



- 1. Fabricate from steel bar stock, 1-1/8 or 1-1/4 in. dia. X 4-5/8 in. long.
- 2. All dimensions shown are in inches.
- 3. All external surfaces must be free of scratches and burrs.

Figure C-3
Differential Resistance Tool





<u>Description</u>

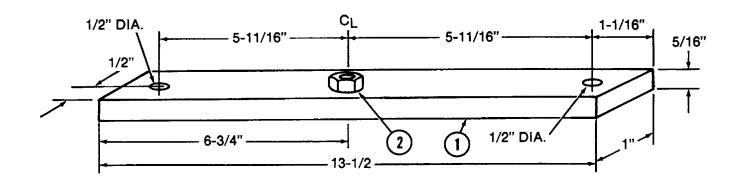
- 1 Round Steel Stock, NSN 9510-00-199-1084
- 2 Hexagon Nut, NSN 5310-00-763-8920
- 3 Flat Bar Stock, NSN 9515-00-204-3972 (2)

# **WARNING**

Wear eye shields and protective gloves when fabricating this tool. Failure to do so may result in serious personal injury.

- 1. Fabricate as shown in illustration.
- 2. All dimensions are in inches.

Figure C-4
Planetary Hub Drag Tool

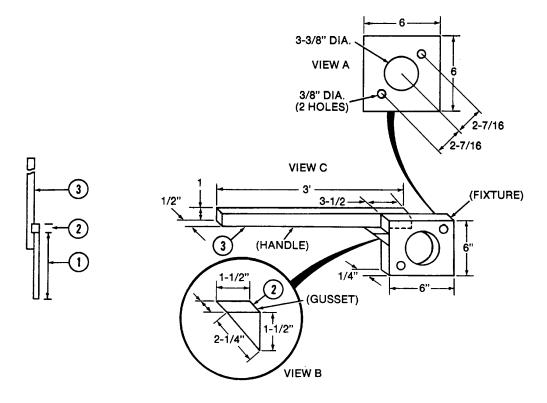


<u>Item</u>	<u>Description</u>			
1	Steel Bar Stock, 5/16 in. X 1 in. x 13-1/2 in.			
2	Hexagon Nut, 1/2-16, NSN 5310-01-270-173			

Wear eye shields and protective gloves when drilling holes in the bar stock. Heated and flying metal parts may cause serious personal injury.

- 1. Drill two 1/2 inch diameter holes in the bar stock at the locations shown in the above illustration.
- 2. Remove burrs with a hand file.
- 3. Center hexagon nut (2) on bar stock (1) at location shown in above illustration.
- 4. Hold nut in place with a C-clamp, and weld a single layer bead around the circumference of the nut.

Figure C-5 Yoke Tool Nut

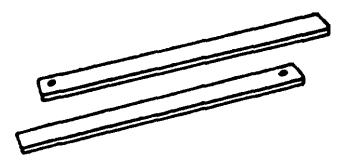


<u>Item</u>	<u>Description</u>			
1	Steel Plate, 1/4 in X 6 in X 6 in			
2	Steel Bar Stock, 1-1/2 in X 1-1/2 in X 3/8 in			
3	Steel Bar Stock, 1/2 in. X 1 in. X 3 ft.			

Wear eye shields and protective gloves when fabricating the yoke nut tool. Flying metal particles and heated metal may cause serious personal injury.

- 1. Cut steel plate (1) to size 6" X 6" square as shown in view A. Remove all burrs and sharp edges with a hand file.
- 2. Drill two 3/8" holes in plate as shown in view A.
- 3. Cut out a 3-3/8" diameter hole in plate as shown in view A.
- 4. Build a gusset, as shown in view B, from steel bar stock (2).
- 5. Hold bar stock (2) to steel plate (1), as shown in view C, with a C-clamp, and spot weld the two parts together.
- 6. Place gusset (view B) in the area shown in view C.
- 7. Weld a single bead over all adjoining metal.

Figure C-6
Transmission Alignment Bars



# **Alignment Bars Dimension Data**

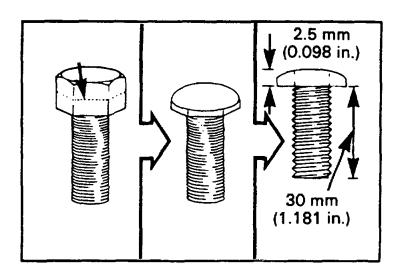
Bar Size

Bars Used * At	Width (in.)	Length Height (in)	Number of (in.)	Bars Required
First Stage Clutch Pack, Engine Side	2	12	5/8	2
First Stage Clutch Pack, Non-Engine Side	2	12	1/8	2
Second Stage Clutch Pack, Engine Side	2	12	1/8	2
Second Stage Clutch Pack, Non-Engine Side	2	12	1/4	2
Third Stage Clutch Pack, Engine Side Only	2	12	1/16	2

Engine and non-engine side designations refer to clutch pack orientation when transmission is installed in vehicle.

1. Fabricate bars from steel bar stock to the dimensions shown above.

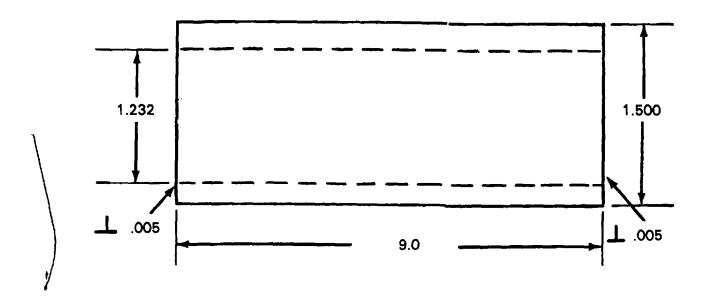
Figure C-7
Bearing Removal/Installation Tool



Wear eye shields and protective gloves when fabricating the bearing removal/installation tool. Flying metal particles and heated metal may cause serious personal injury.

- 1. Fabricate from 6mm capscrew.
- 2. All external surfaces must be free of scratches and burrs.

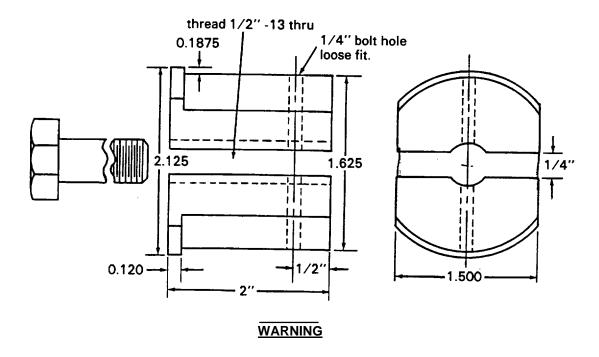
Figure C-8
Hydraulic Piston Pump - Driveshaft/Pump Housing Bearing Removal Tool



Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine removal tool from 1-1/2 inch steel pipe per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges.

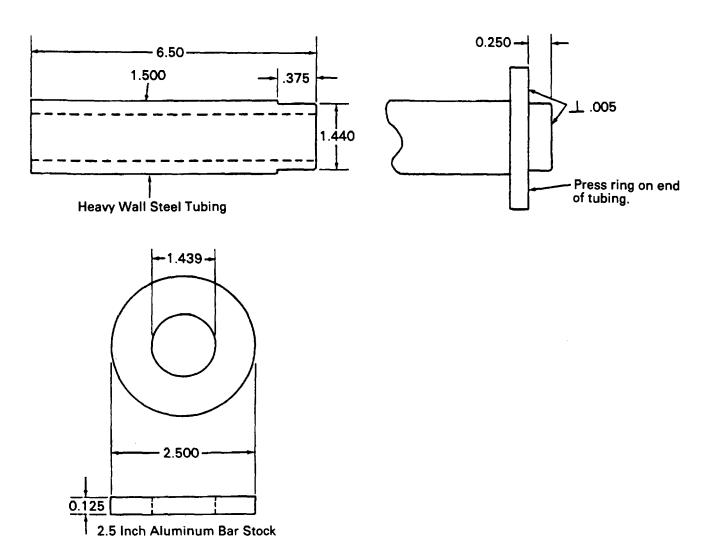
Figure C-9
Hydraulic Piston Pump - Housing Bearing Race Removal Tool



Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine removal tool from 2 inch long steel bar stock per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges. Use a 5 inch long 1/2-13 hex head screw with this tool.

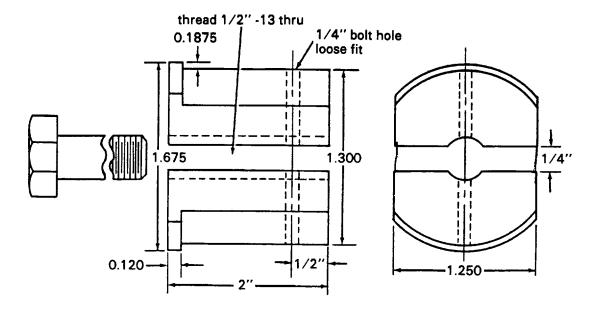
Figure C-10 Hydraulic Piston Pump - Shaft Seal Driver



Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine installation tool from heavy wall steel tubing and aluminum bar stock per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges.

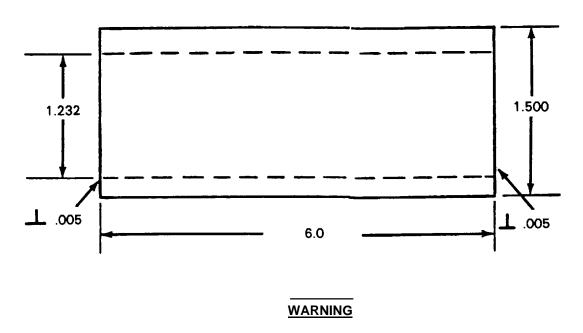
Figure C-11 Hydraulic Piston Pump - Valve Block Bearing Race Removal Tool



Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine removal tool from 2 inch long steel bar stock per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges. Use a 5 inch long 1/2-13 hex head screw with this tool.

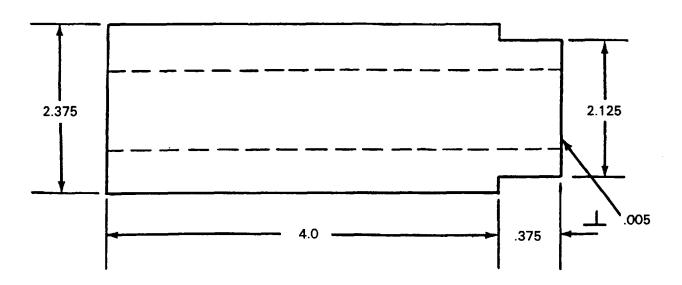
Figure C-12 Hydraulic Piston Pump - Driveshaft/Pup Housing Bearing Installation Tool



Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine installation tool from 1-1/2 inch steel pipe per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges.

Figure C-13 Hydraulic Piston Pump - Housing Bearing Race Installation Tool



## WARNING

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

Machine installation tool from schedule 80 steel pipe per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges.

1.900

Figure C-14
Hydraulic Piston Pump - Valve Block Bearing Race Installation Tool

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

WARNING

Machine installation tool from schedule 80 steel pipe per the dimensions on sketch. All surfaces are to be smooth and flat. Radius or chamfer all sharp edges.

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- 1 Meter = 100 Centimeters = 1.000 Millimeters = 39.37 Inches
- 1 Kilometer = 1.000 Meters = 0.621 Miles

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- 1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
- 1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles CUBIC MEASURE
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- 1 Cu Meter = 1.000.000 Cu Centimeters = 35.31 Cu Feet

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1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces 1 Liter = 1.000 Milliters = 33.82 Fluid Ounces

## TEMPERATURE

5/9 (°+ -32) = °C

212° Fahrenheit is equivalent to 100° Celsius

90° Fahrenheit is equivalent to 32.2° Celsius

32° Fahrenheit is equivalent to 0° Celsius

9/5 C° +32 = F°

### WEIGHTS

- 1 Gram = 0.001 Kilograms = 1,000 Milligrams = 0.035 Ounces
- 1 Kilogram = 1.000 Grams = 2.2 1 h.
- I Metric Ton = 1,000 Kilograms = 1 Megagram = 1.1 Short Tons

<b>APPROXIMATE</b>	CONVERSIO	N FACTORS
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